The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

Orthopedic Surgery

Gynecology · Plastic Surgery

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FIFTY-FIFTH YEAR OF CONTINUOUS PUBLICATION

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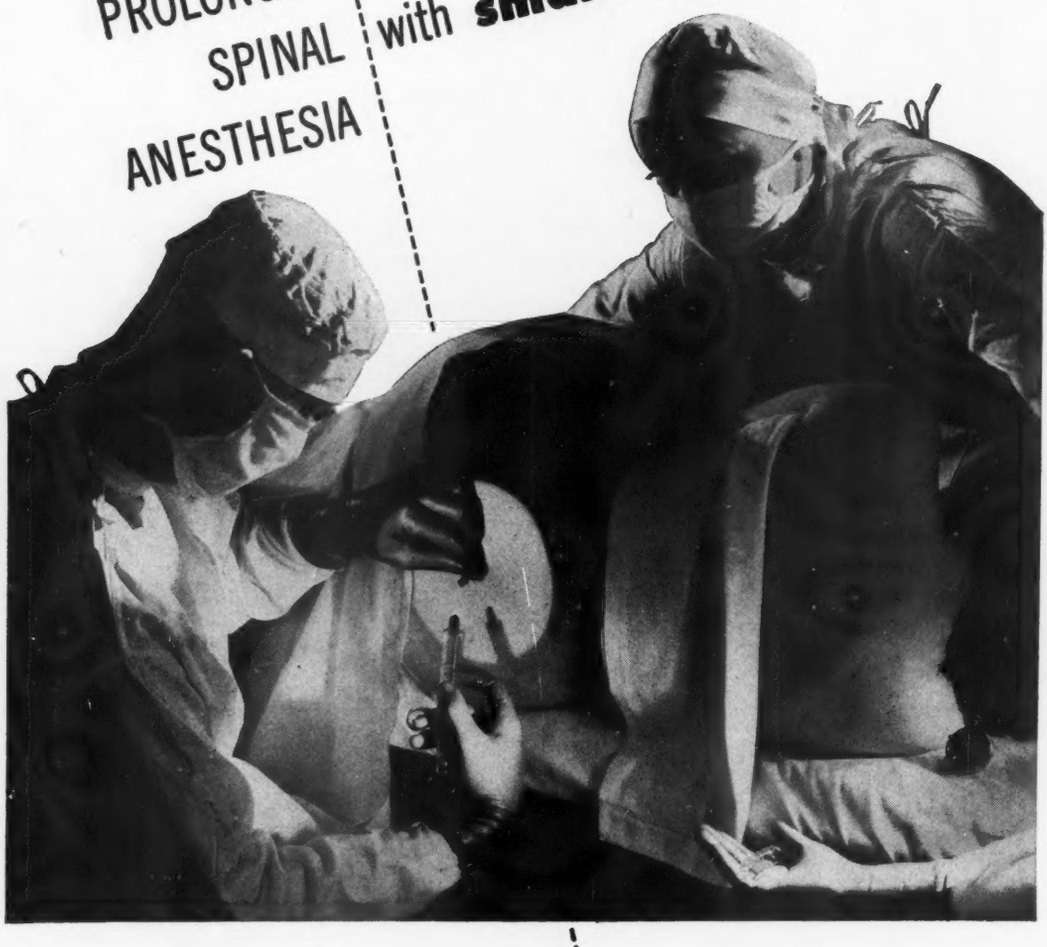

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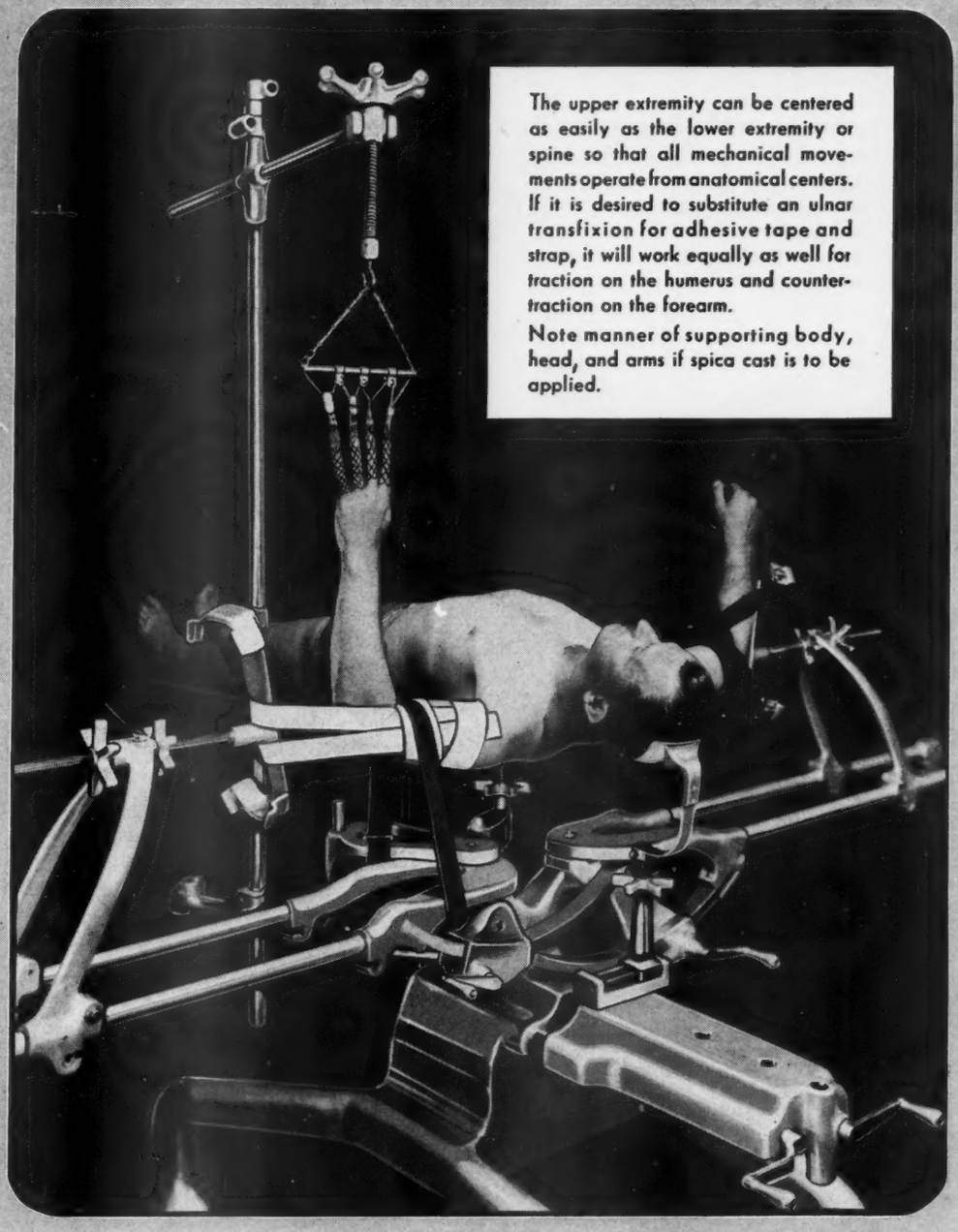

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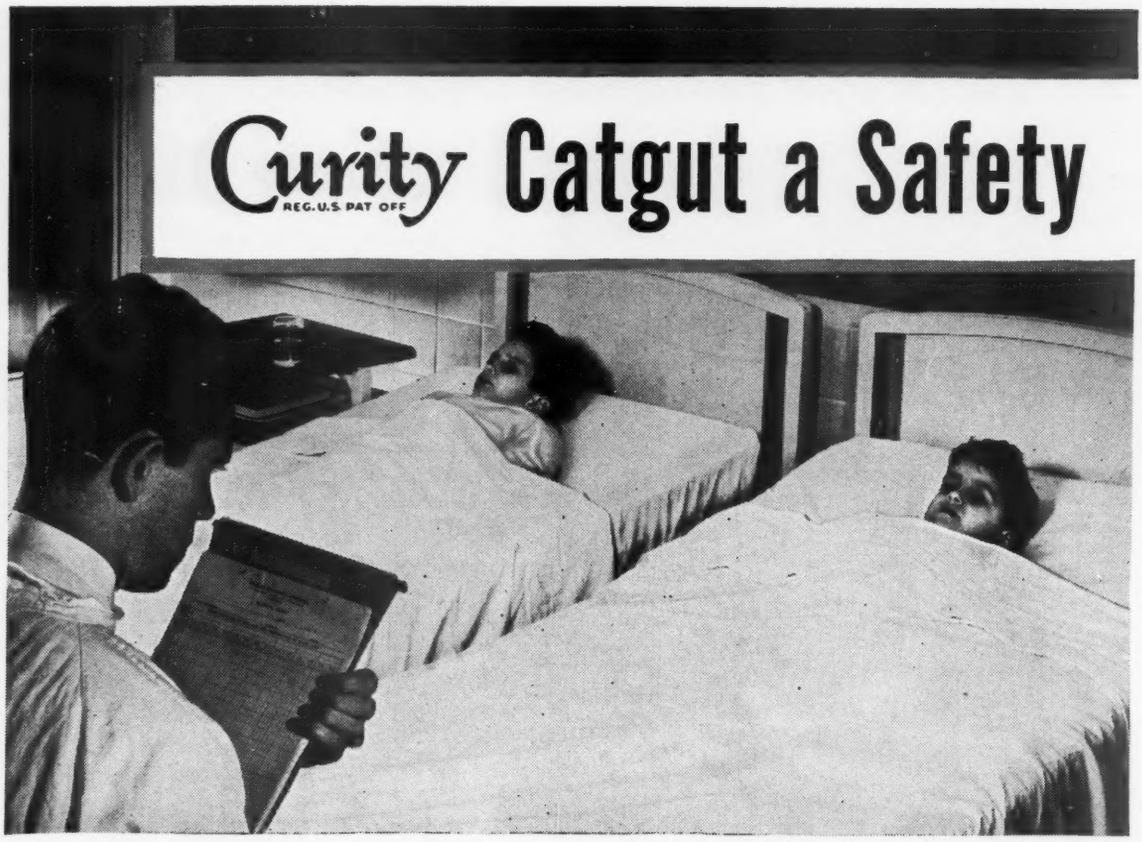

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Infants and Children Withstand Trauma Poorly

"In infancy and childhood, the body is far from static. It is changing rapidly in proportions and form, physiologic processes are at the height of their activity, metabolism is rapid, and the growth of organs and the evolution of systems is in the ascendancy. The body is in a state of unstable equilibrium when disease, accident, or malformation has a proportionately greater effect than in later life. The endocrine balance is easily disturbed; dehydration or interruption of nutrition produces more profound effects than later and a serious disturbance of function may have far-reaching consequences."*

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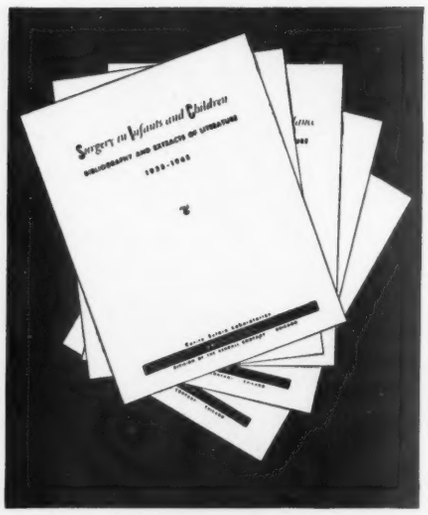
*Coe, H. E.: Relation of Growth and Development to Pediatric Surgery. Rocky Mountain M. J. 39: 838-839 (December), 1942.

**Mason, R. L.: Preoperative and Postoperative Treatment. Philadelphia, W. B. Saunders Co., 1937, p. 23.



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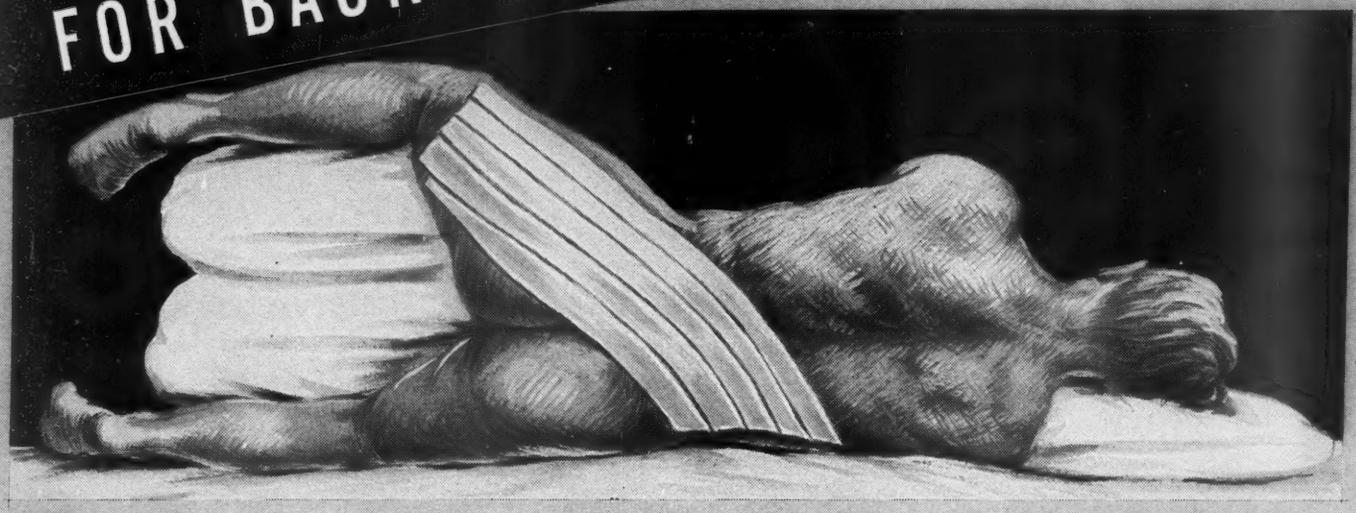

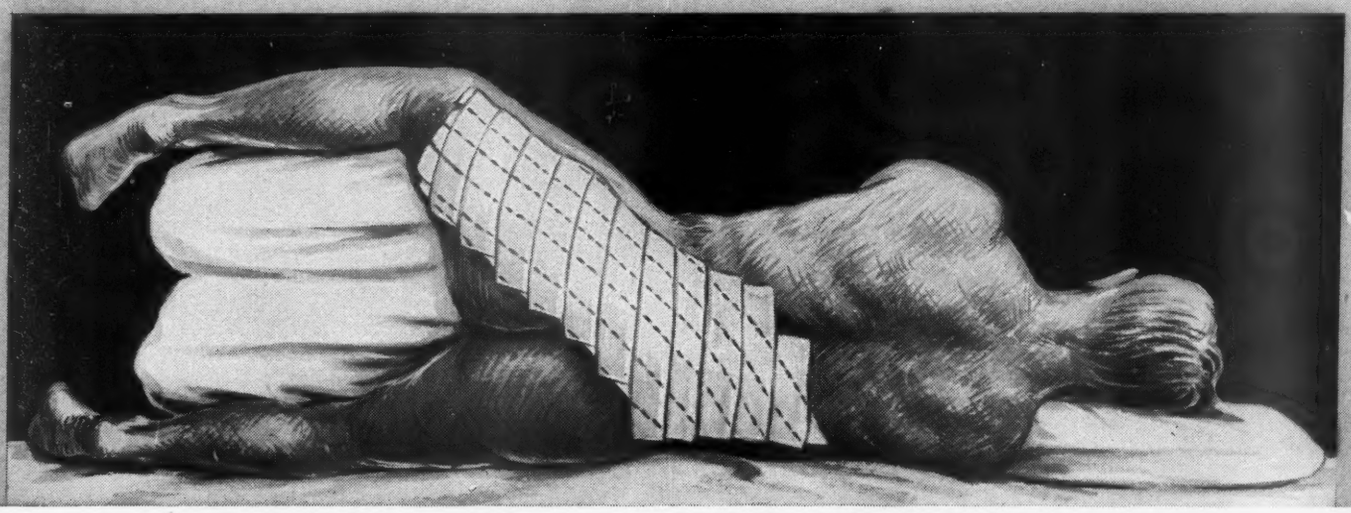

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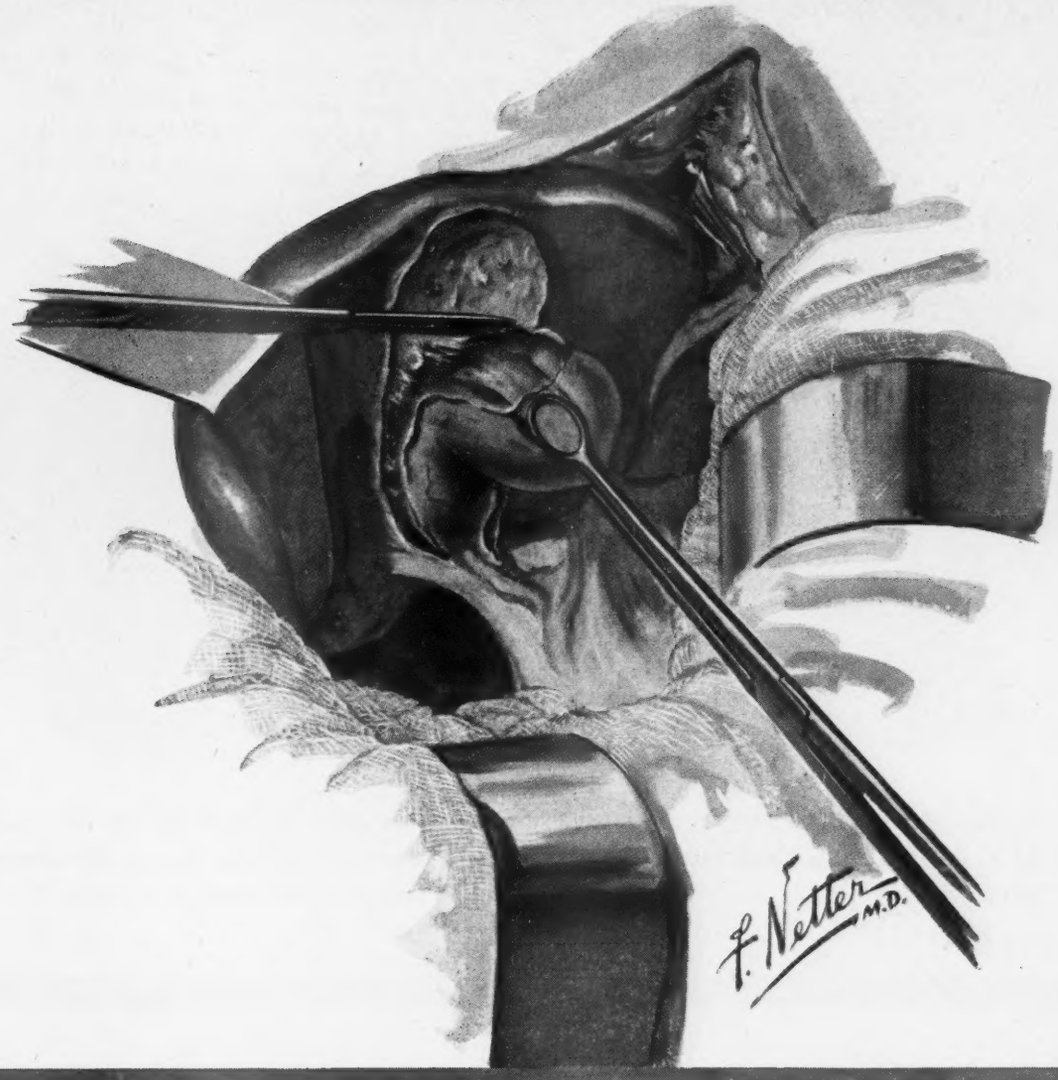

CHOLECYSTECTOMY, from the fundus down

The technique of gall bladder excision often is considered relatively routine because of the frequency with which this operation is performed. Cholecystectomy nevertheless may be an extremely difficult operation at times because of complications, adhesions, anomalies, or poor accessibility. It is important that the surgeon have good suture and ligature materials to work with. He needs ligatures that will remain firm and secure on the cystic artery and cystic duct, and sutures that will hold an obese and weakened abdominal wall. He needs a suture and ligature material that is easy to work with in deep and poorly accessible recesses—one which is pliable and which ties down firmly into secure knots.

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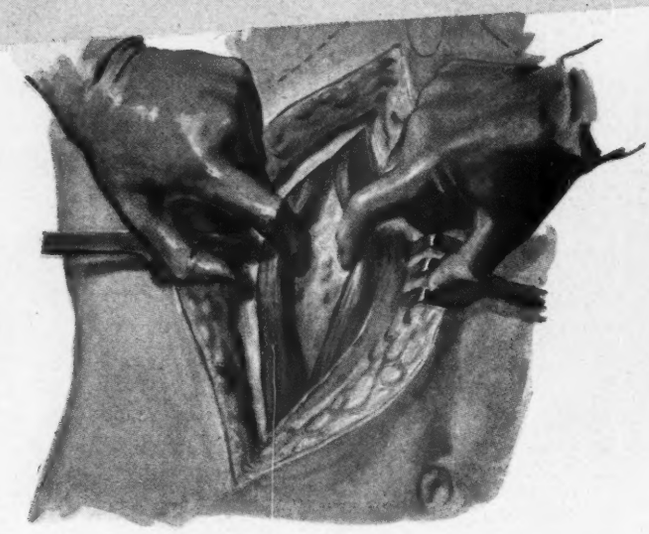
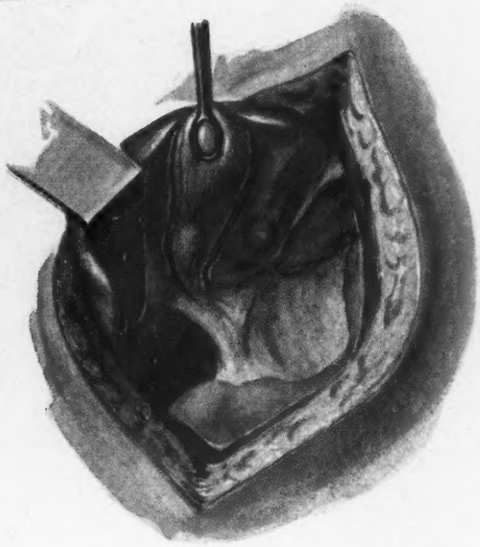
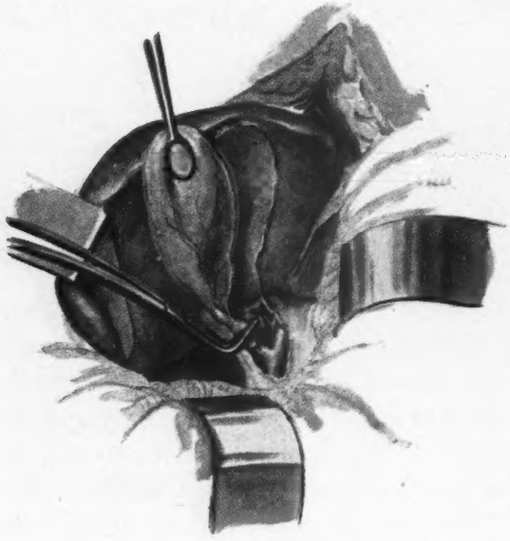


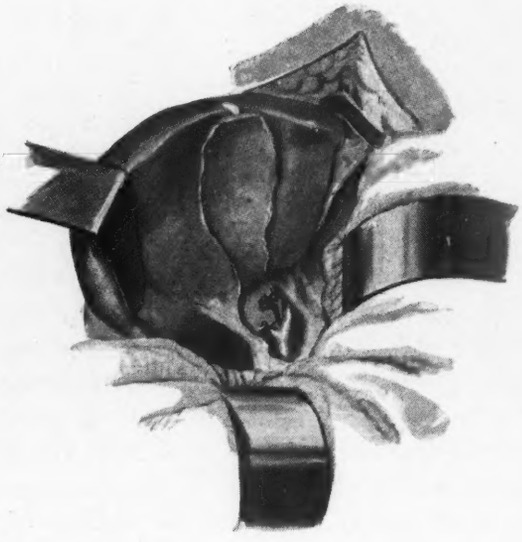
I. Right upper rectus muscle-splitting incision. Skin, fat and fascia divided obliquely—muscle fibers separated.



II. After gall bladder has been palpated for stones, it is drawn up out of abdomen by ring forceps. Peritoneum incised around gall bladder.

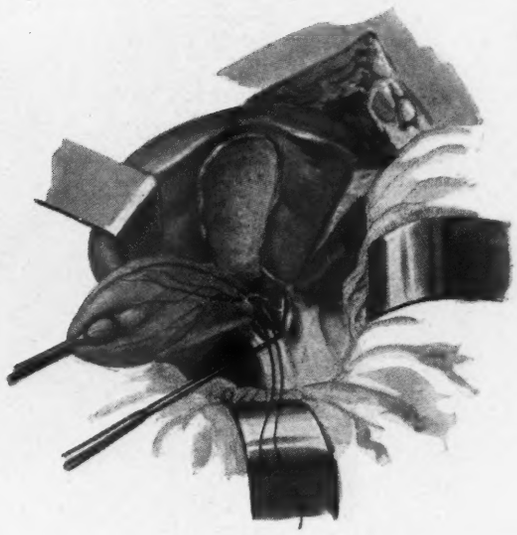


V. Cystic duct exposed, palpated for stones, then ligated about ¼ inch from common duct. Right angle clamp applied prior to division.



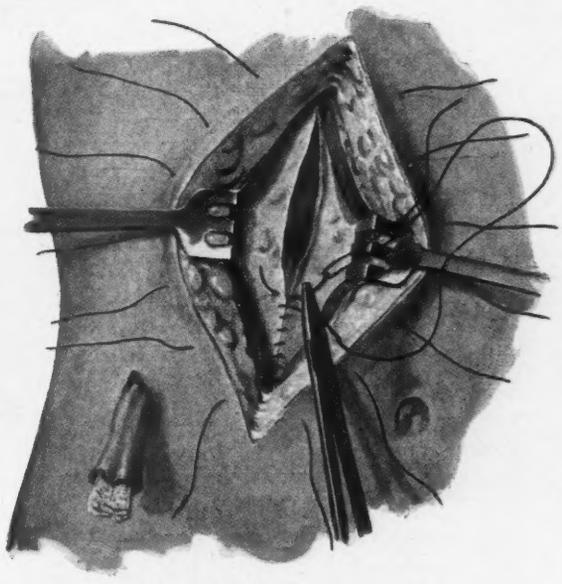
VI. Gall bladder dissected free and completely removed. Common duct is palpated for stones.

III. Dissection carried out from above down. Pads and Deaver retractors mesially and inferiorly to hold away stomach and intestines.



IV. Cystic vessels exposed on gall bladder neck, freed, ligated with chromic catgut and divided.

VII. Penrose drain inserted to Morrison's pouch running past liver bed.



VIII. Drain drawn out through lateral stab wound. Abdomen closed in layers. Through and through silk sutures also used for obese abdomens.

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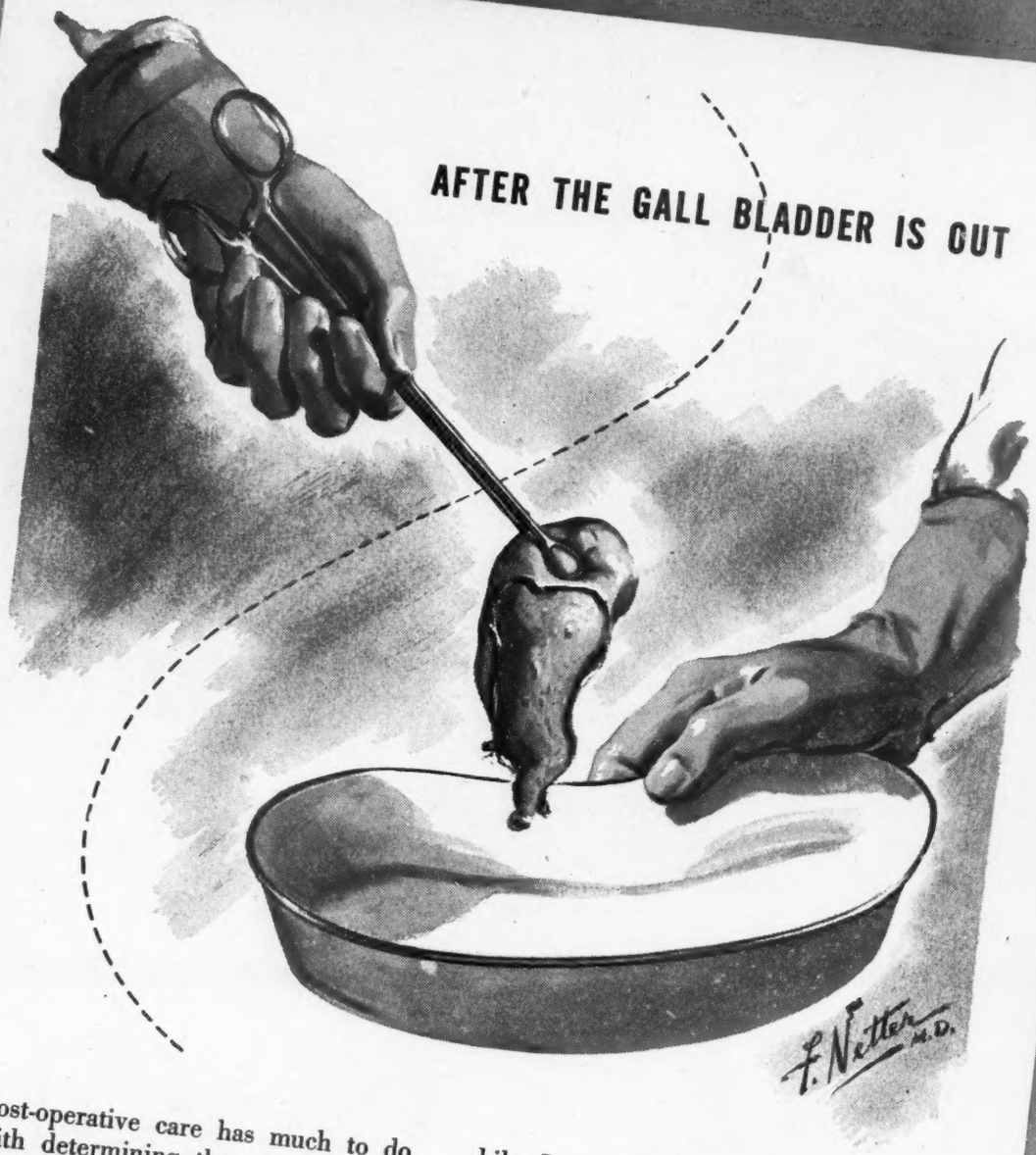

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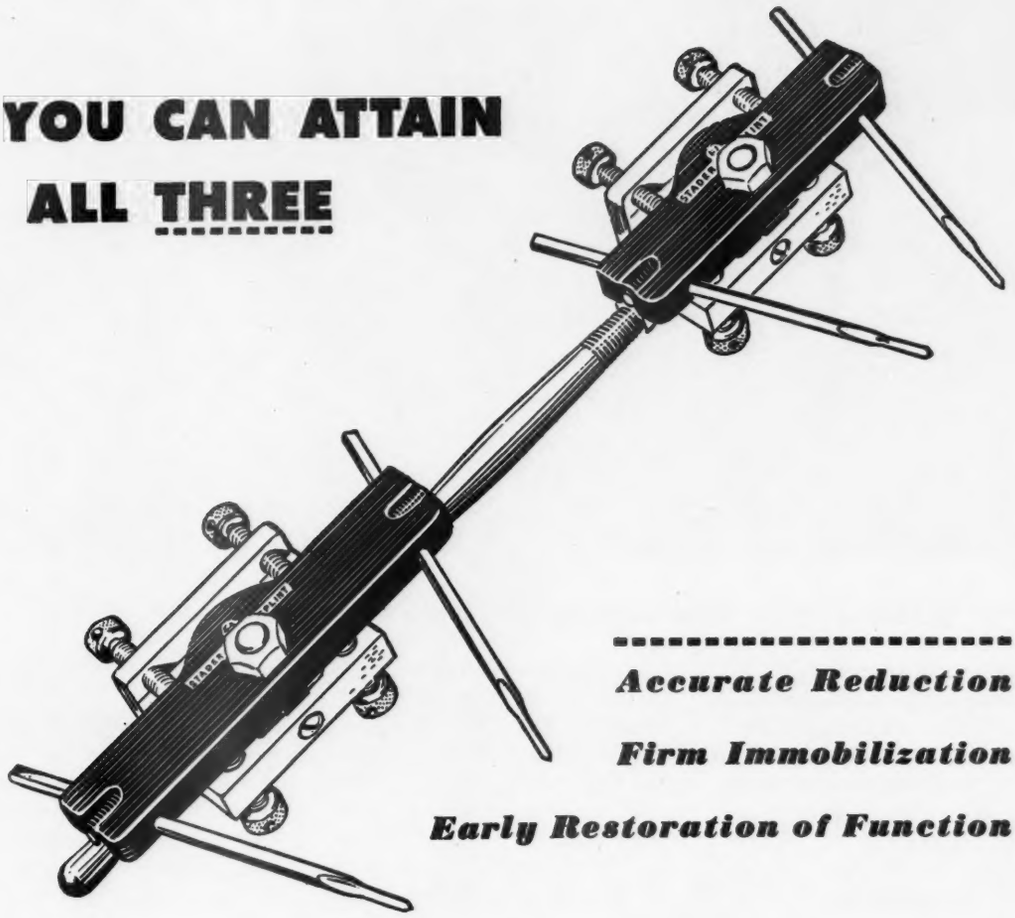

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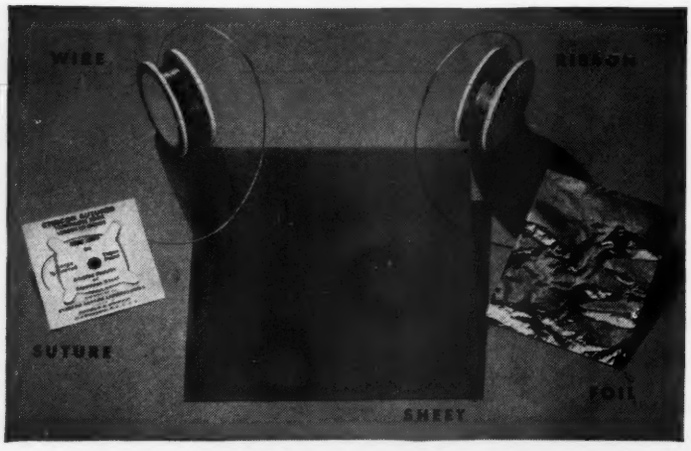

*Olson, C. T.: "The Place of Tantalum in Surgery," Industrial Medicine, 13: 917, November, 1944.

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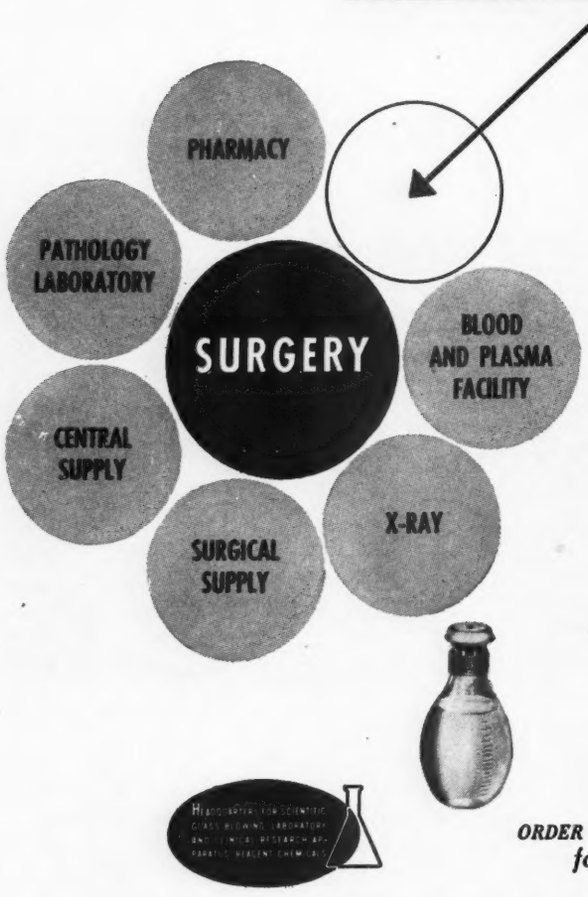

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**Kelly, M.: Anesth. & Analg. 19:107, 1940.*

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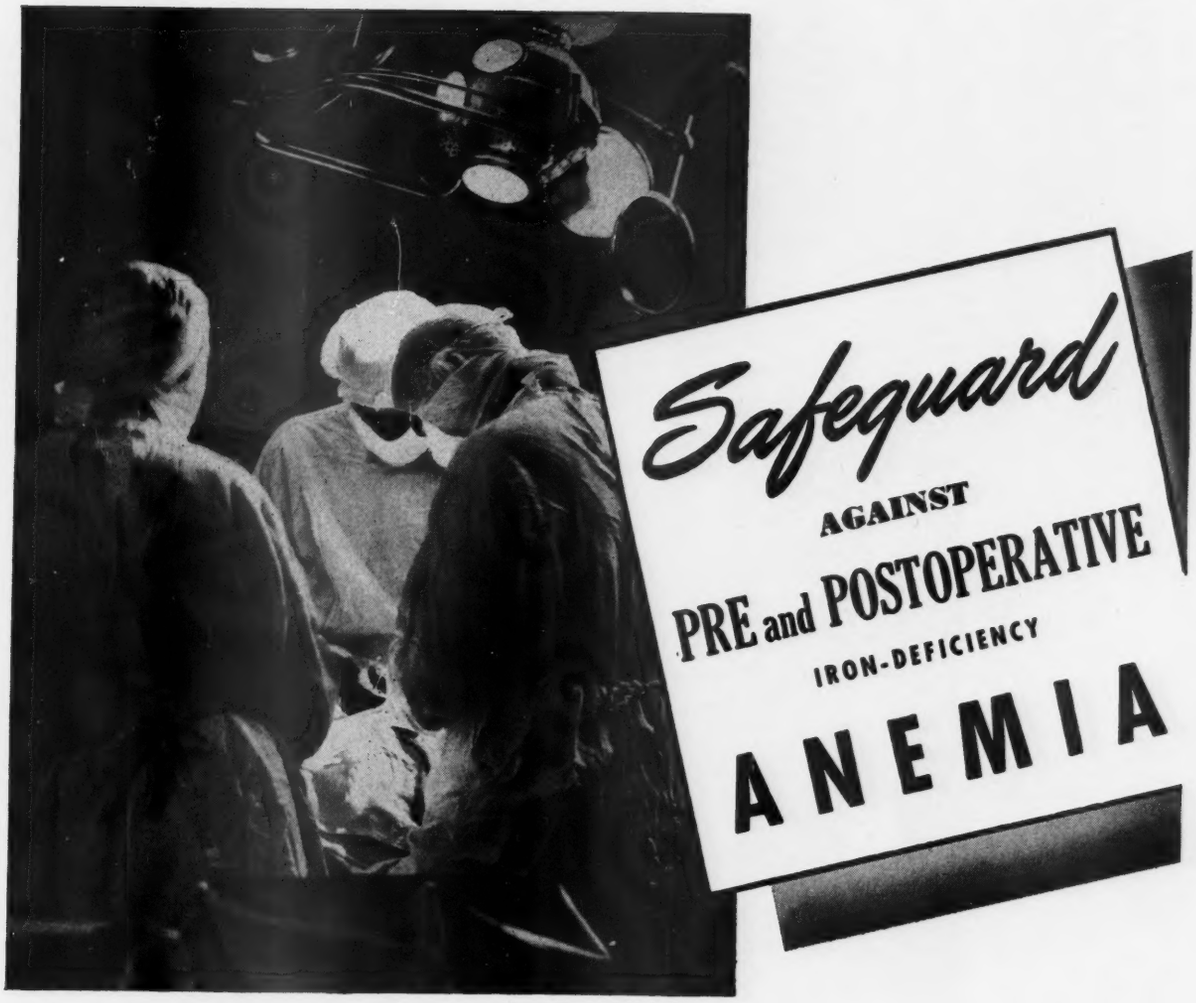

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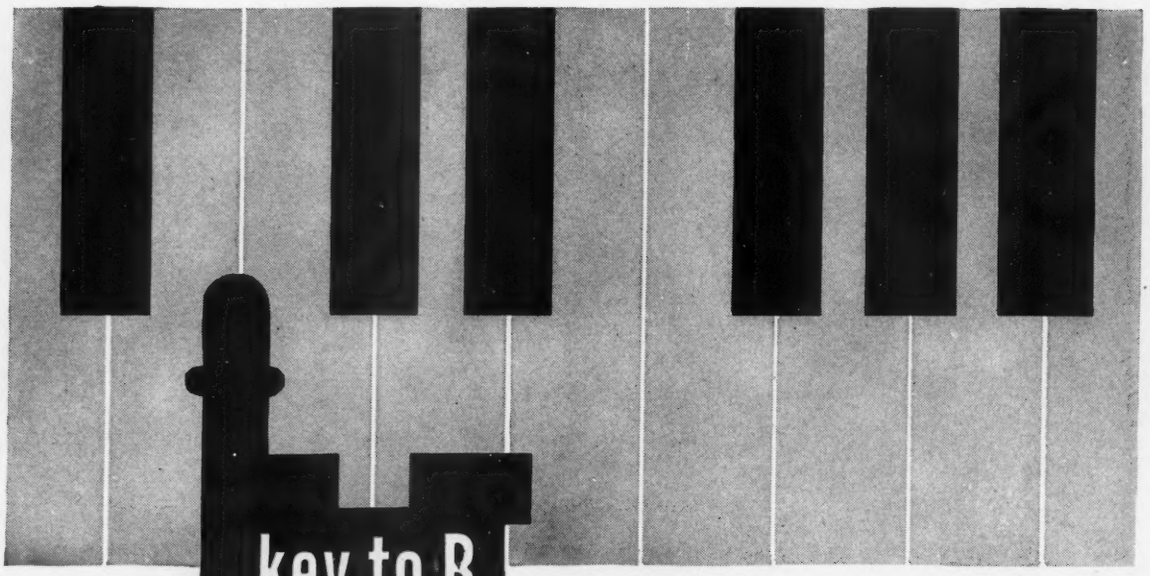

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1. Canadian J. Public Health *31*:428 (Sept.) 1940. 2. New England J. Med. *223*:265 (Aug. 22) 1940. 3. Current Comment: J.A.M.A. *129*:74 (Sept. 1) 1945.

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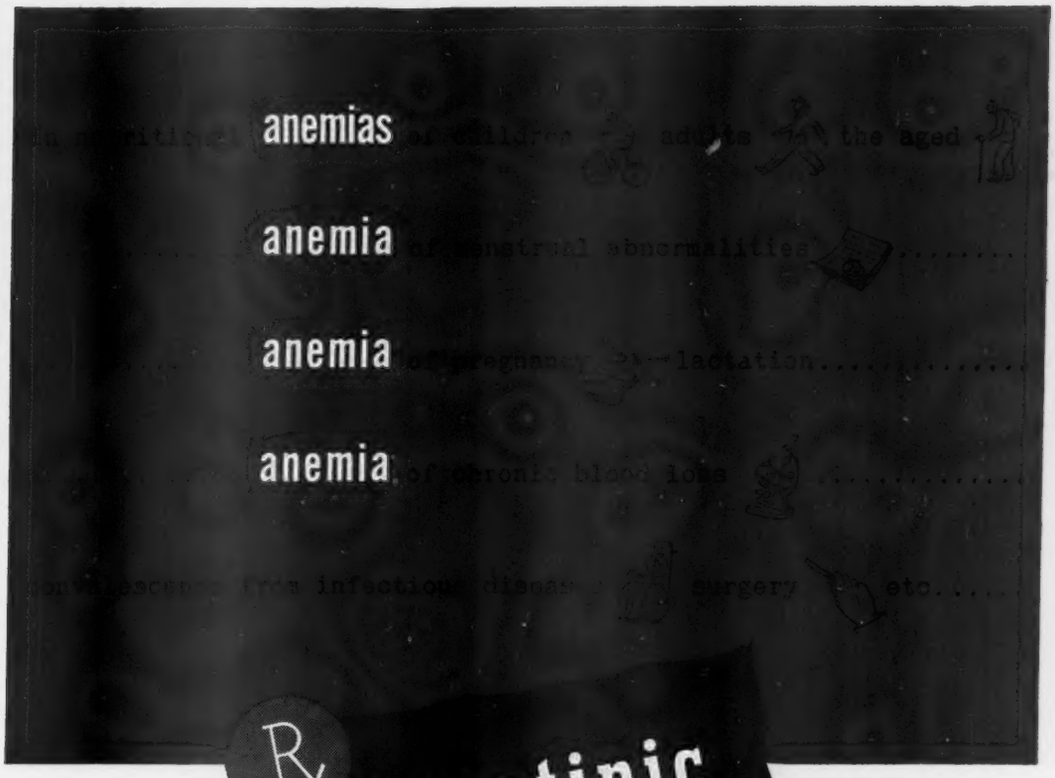

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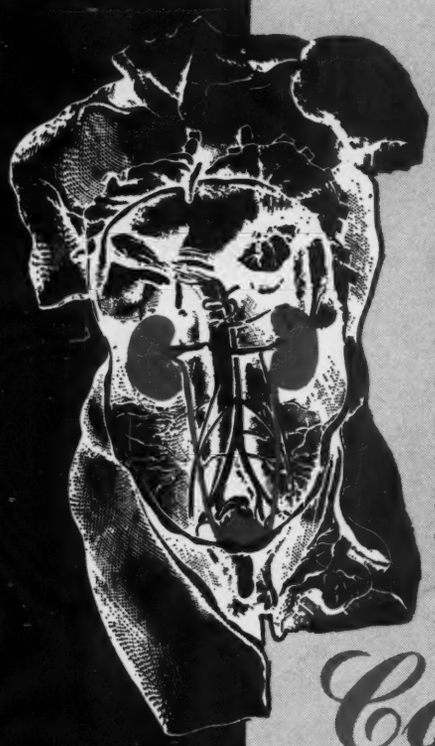

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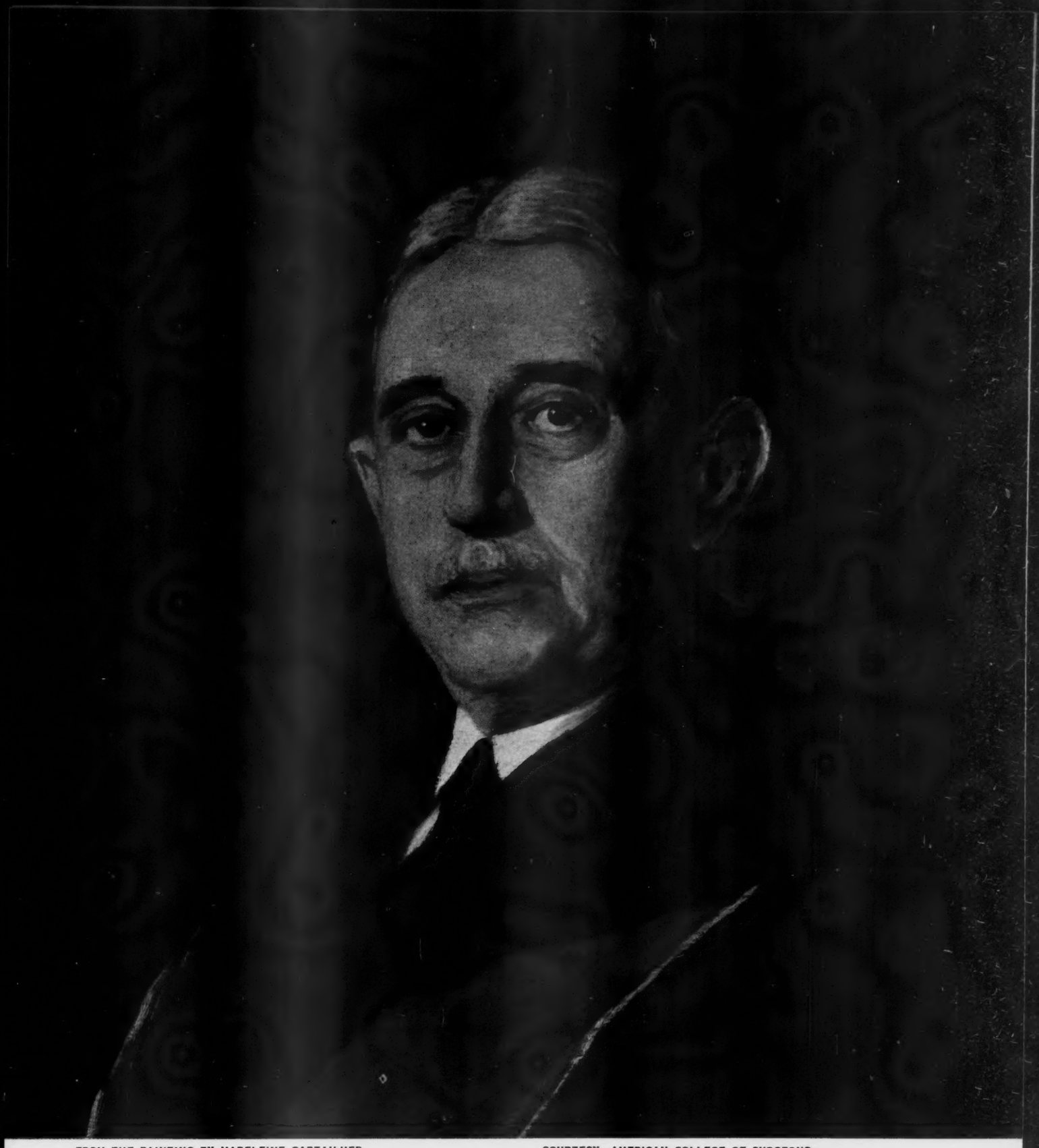

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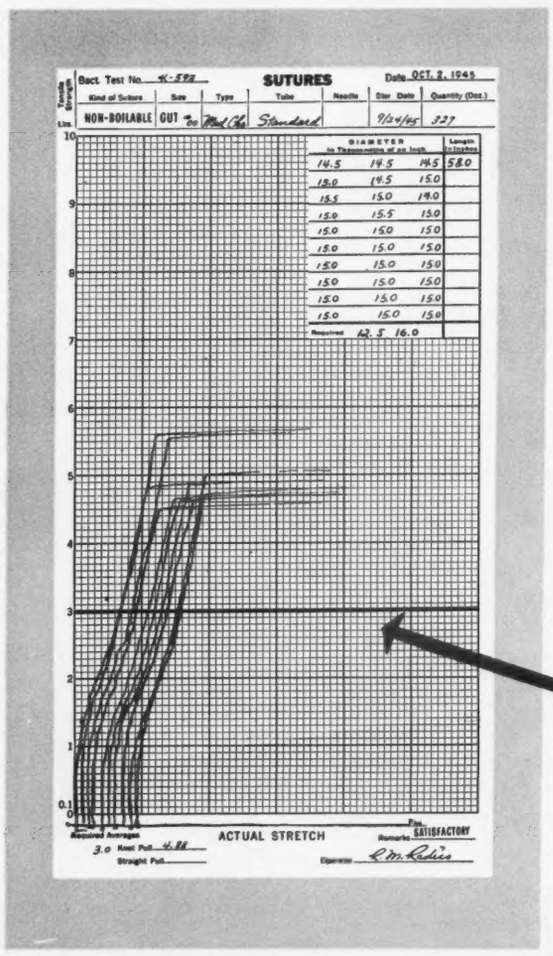

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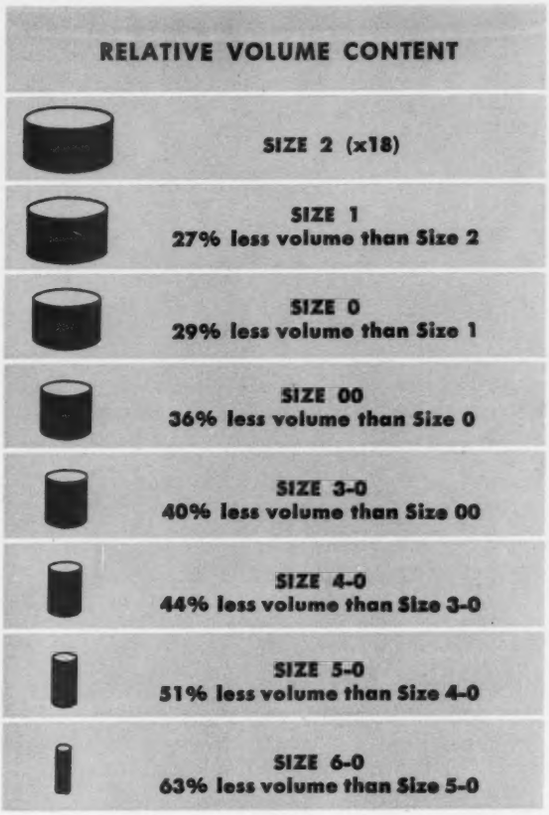

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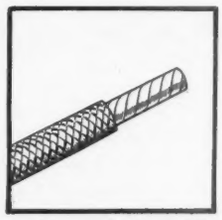

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Editorial

HOSPITAL CONVALESCENCE MANAGEMENT

DURING the war years, a new medical service was created in the armed forces: reconditioning. Camouflaged under this name was a new departure in medical thinking, a scientific approach to the problems of convalescence management. In the centuries during which medicine has been practiced by specialized personnel, very little organized attention was given to convalescence. The average physician begins to lose interest as soon as the disease or injury he is treating is brought under control. For him, the intellectual problem has been solved.

Yet, second only to the greater challenge of prevention, is that of convalescence management in medicine today with its concomitant of maximum rehabilitation. Convalescence is the greatest portion in the longitudinal chronological section of most diseases and injuries. It is this feature which confers upon convalescence its social and economic significance. It is this feature which logically forced the armed forces into a consideration of convalescence on a scientific and practical basis.

Large scale warfare in the recent situation brought floods of casualties, concentrated in a short space of time, taxing even the large physical and personnel resources of this relatively well medically developed nation. In order to meet the urgent military needs, attention was focussed upon the process of convalescence in order to shorten it, thus freeing hospital facilities for a more rapid turnover. Not a lesser consideration was the moral obligation of a nation to provide for the welfare of those citizens who had sacrificed themselves for the common good by restoring them to the best possible status, in the best possible manner.

The general structure and objectives of the reconditioning program have been described in detail elsewhere,[1,2] as well as in many pamphlets and directives issued by the War and Navy Departments.[3] For this presentation only the briefest of summaries will be made. Reconditioning in the armed services consisted of guidance in personal affairs and readjustments, orientation of the individual to an understanding of the basic reasons for the worth-whileness of his sacrifices, educational opportunities, planned recreation, physical training and occupational therapy.

As in all large scale endeavors with new concepts, the judgments formed varied with the bias of the observer as well as the

efficiency of the organization he observed. Those of us who were fortunate enough to see well run, efficient services could not fail to be impressed with successful accomplishment.

Let us contrast the course of a patient in a military hospital before and after establishment of efficient reconditioning services. In the first case, the patient is admitted, receives emergent treatment if indicated, and is sent to a ward. He is examined and treated by a medical officer from whom he receives less and less attention as his condition is controlled. Finally, he is allowed up "progressively," and ultimately discharged from the hospital. While convalescent he reads all the available magazines, visits the recreation hall, goes to an occasional moving picture, and interminably plays cards or "shoots crap." During the convalescent period, which may last weeks or months, he is terribly bored, discouraged; and if left with a residual disability, he is confused, perhaps visiting the chaplain or the Red Cross social worker for advice.

The difference afforded by a well functioning reconditioning service is marked. Unless he is acutely ill, immediately upon admission the patient receives a brochure which explains the hospital, the facilities and services it affords.[4] Within the first few days, or as soon as his physician deems him able, he is interviewed by a trained counselor who questions him specifically concerning his personal problems, educational needs and interests. He is placed in the educational program by enrollment in one of its activities.

All activities are permitted only to the limit considered advisable by the physician in immediate charge of the case. However, each patient is classified by the physician as soon as he is able to participate, and instructors visit the wards for individual attention to bed patients. Ambulatory patients visit classrooms where they receive instruction from a wide variety of academic and prevocational subjects. In some hospitals, the range of instructions has varied from higher mathematics to radio technology, from simple reading and writing for illiterates to job-printing.[4]

At the same time, while still a bed patient, the patient participates in periods of physical exercise for short periods during the day, which all receive in unison from trained physical instructors. The exercises are standardized and modified for various types of disabilities.[3] Where possible, the element of competition is introduced by the use of simple games. As the patient becomes ambulatory, he graduates to more strenuous physical activities which are administered in the gymnasium and swimming pool or outdoors and which preferably include modified competitive sports.

Physical and occupational therapy are different modalities which approach the same ends as physical training. The separation of these fields in relation to patient care is more a consequence of their historical development than of logic. The patient receives both as requested by his physician. Therapists visit the wards to administer physical therapy treatments and to bring craft materials and prescribed activities for the individual patient. In the latter instance, craft work is chosen to suit the patients' needs for retraining of muscles and nerves in accordance with their interests, so that motivation is provided for sustained effort at the tasks.

Industrial therapy may be mentioned briefly as it was tried in the "Birmingham plan" at Birmingham General Hospital. By cooperation with one of the major aircraft producers, a branch shop of the company was set up in conjunction with the hospital. Selected convalescent patients, under careful supervision and specially trained foremen, actually worked on a limited scale in the production of aircraft parts, receiving regular wage scales for their labor. It had a great morale building effect as these handicapped men were able to

see a practical demonstration of their employability, indeed took home in cash the fruits of the demonstration. Though this approach has been an interesting one, it has remained in an experimental stage.

Recreation is provided systematically. Entertainment is obtained through the Red Cross and other local agencies, and shows are played both in the hospital auditorium and by smaller units in the wards themselves. Moving pictures also are brought to the wards, especially through the use of new automatic machines, which require little attention, and are moved as a unit with incorporated screen, needing only a slightly dimmed light. Patient participation in amateur entertainment is encouraged.

Finally, the guidance process started with the patient's admission is continued throughout his stay. Counselors check on his participation and answer his new questions. Testing services are offered, both for interests and abilities. Occupational counselling is an important part of the program. When the patient receives his final interview and is directed to the various civilian agencies that exist for his aid, a great deal has already been accomplished in speeding adjustments to illness or injury, and his social and mental adaptations to a handicap, if one will remain.

The use of such methods as those described in making the process of convalescence a more eventful one rests on a basis of physiological and psychological considerations which is continually expanding and becoming more sound. There has been a lag in the establishment of conclusive scientific evidence of the value of reconditioning activities because of the nature of the subject. The field developed under the stress of war, and it was not possible to conduct carefully controlled studies in the press of urgent needs. Further, the matter is different, for example, from the testing of a new drug. When sulfonamides or the new antibiotics appeared on the scene, it was a relatively simple matter for application of the scientific method. Animal experiments could be performed. Alternate cases could be treated by two methods, using subjects from a relatively homogeneous population. End points are clear. Organisms disappear, temperature descends. Conclusions can be drawn rapidly. However, in the evaluation of reconditioning methods, considerations are more complex. Too many other factors affect the length of convalescence. Objective criteria for such intangibles as personality adjustments are difficult to find and apply.

Nevertheless, certain things became evident to workers in the field. While results could not be measured in terms of days or personalities saved, some facts became obvious. An amputee who was subjected to intensive physical training and education in the use of his prosthesis was able to perform more tasks with it than an amputee who was simply given a prosthesis and a few perfunctory instructions for its use. Likewise, the amputee who received intensive guidance and exploration of his occupational possibilities was much better able to adapt to his new situation in a favorable manner than the patient who did not receive these advantages. Pneumonia patients who received definite graduated physical training in the hospital were returned to full duty faster and better able to carry on than those who simply sat around the wards for a few days after an arbitrary period of complete bed rest.

Recently there has been a growing interest in the physiological basis for reconditioning activities.[5] In 1944, a whole series of articles appeared on the abuse of rest in various aspects of medical practise. Bed rest has been found by certain observers to have an effect upon vital metabolic processes, such as the utilization of carbohydrates.[6] Circulatory stasis associated with bed rest has been incriminated as an etiological factor in thrombophlebitis and phlebothrombosis, with the subsequent

dangers of embolization. Calcium excretion increases and results in osteoporosis with increased incidence of urinary calculi during prolonged bed rest. Early ambulation following major operative procedures is becoming increasingly popular.[7] Now clinical observations are being made breaking away from orthodox thinking about the significance of rest. Of interest is a recent article from an AAF hospital suggesting that complete bed rest may not favorably influence the course of rheumatic fever, if judgment is based upon the patient's subjective complaints rather than upon the usual criteria.[8]

Under the stimulus of the Baruch Committee on Physical Medicine, a new body of basic study is arising concerning the metabolism of resting subjects. For example, what is the effect of rest on tonus of the muscular and circulatory systems? There is no doubt that peripheral circulatory tonus is altered and becomes more unstable during prolonged bed rest. After a period of bed rest, which need not be overly prolonged, resumption of erect posture and limited activity is associated with asthenia, easy fatigability, sweats and flushes, near-syncopes, which manifest unstable peripheral circulatory conditions. Effects on rest on cardiac output over long periods are less well known than the acute changes.

Application of reconditioning principles to voluntary hospitals has been suggested only recently. Lessons have been drawn from military experience in reconditioning[9] as well as from more theoretical considerations.[10] In the former instance, Gwynn recommends extensive administrative changes, with establishment of a reconditioning service on the same professional level as the surgical and medical services. He also recommends facilities based, like the administrative suggestions, upon his military experience. Such a program would be effective and complete and, in a large civilian hospital with suitable patient population, would certainly make an excellent basis for an effective program. However, it is suitable for operation only on a large scale, and a hospital of more than 1,000 beds would be required to permit economical operation of many features. Small hospitals cannot hope to afford space or money for gymnasium and swimming pool. In military hospitals, pre-vocational shops often included printing, radio, jewelry, woodwork, mechanic and welding shops, photographic laboratories, classrooms and business machines. For men in rural areas, gardens and scientific farming experiments were conducted. An approach of this type is not practical for small hospitals or for many large ones under present circumstances. Furthermore, the nature of the patient populations varies considerably in civilian hospitals from that found in military institutions. Special problems are introduced by the wide age spread from infancy to old age and by the varying ratio of acute cases.

Nevertheless, the need for a scientific and humanistic approach to convalescence management exists, and new methods must be devised for application of reconditioning methods to civilian medicine. It is only a relatively short time since the concept of preventive medicine became prominent, but the profession now recognizes its deep and important responsibilities in this regard. The physician has a moral responsibility to his patients, not only during acute illness but at all times. He is responsible before illness or injury for hygiene and prophylaxis. He is responsible likewise during the period of recovery for convalescence to be managed efficiently and to the patient's best advantage. When the patient lies in bed desperately fretting at his idleness, reading comic magazines or "true story" magazines, wondering at the comments passed by the staff on rounds in his presence, the responsibility of the profession for that patient's welfare is not being discharged. We all know that this situation occurs

all too often in the hospitals of the present time.

The reason for this situation is not obscure. New therapeutic measures permit much more effective definitive treatment of disease and injury. Attention has been focussed on penicillin, streptomycin, thoracic surgery and other dramatic measures. Specialization has proceeded to a point where the average physician too often sees the patient as one organ system with an appended soma and psyche.

The Baruch Committee on Physical Medicine has taken the lead in developing the ideas of reconditioning and rehabilitation for application to civilian situations. In a recent report,[11] the Subcommittee on Civilian Rehabilitation Centers, under the chairmanship of Dr. Howard A. Rusk, formerly Chief of the Army Air Forces convalescent rehabilitation program, defined the needs for rehabilitation activities on a community level, and presented a carefully thought out plan for the establishment of model centers. However, the concept should be extended from the emphasis on community rehabilitation of handicapped individuals to the application of scientific convalescence management principles to the voluntary hospitals.

It is possible for a hospital of 250 to 500 beds to introduce many of the more essential features of planned convalescence for its patients without incurring unreasonable costs in terms of space, personnel or money. Starting at the beginning, it would be a simple matter for hospitals to issue routinely to patients upon admission a small but attractive brochure describing the hospital routines and the opportunities and facilities afforded the patient. Guidance functions could be considerably improved by enlarging the paid social service staff, bringing the worker into closer contact with the patient. Workers should be assigned specific wards, and visit their wards at specified times, learning to know the patients' problems and taking the initiative in supplying needed counsel.

In most hospitals, recreation is on a very rudimentary level. An auditorium is useful, and most hospitals have them, but much can be done right on the wards. Few hospitals at present make the maximum use of community agencies which can provide entertainment. Local entertainment employers as well as local unions have often proved very profitable sources for cooperation with military entertainment programs and should be explored for civilian voluntary hospitals as well. The new compact units previously described make possible a schedule of ward moving pictures with minimum effort. In hospitals for chronic diseases, more use could be made of excursions to points of interest for ambulatory patients.

Educational institutions in the vicinity of hospitals usually are willing and glad to arrange educational opportunities for patients at the hospitals. Often instructors are willing to give lectures or to conduct practical classes. Full utilization of community resources is rarely found at present. It could be achieved through existing agencies with small effort by better liason mechanisms.

On the basis of Army experience, two occupational therapists could account for a basic program in a hospital of 500 beds. Scheduled ward visits with carts equipped to carry tools and materials could afford facilities for many prescription cases as well as constructive diversion for many others. A small room for storage and preparation, and another for treatment of prescription cases would make possible the initiation of a program which in most hospitals would constitute a real advance.

Many hospitals are already equipped with public address systems channeled to each ward, and often to each bed. Often these are used merely for page systems, or to "pipe in" standard radio broadcasts. Yet these channels offer a wonderful opportunity for educational

programs and morale building activities. Besides the obvious music education, there are possibilities for language instruction, for talks on science, art, readings of poetry, talks on current events and other educational features which can serve to interest the patient in recovery and life.

One physical training instructor could care for approximately six to eight large wards daily, bringing the bed and ambulatory patients a planned and adapted program of exercise such as been previously suggested. A small room could be adapted for use in prescribed corrective exercises.

These suggestions are intended only as an indication of the possibilities for application of the new approach to convalescence. The chance for using individual initiative and ingenuity in developing inexpensive opportunities for the patient is endless.

These suggestions have been directed at the small hospital, but the concepts also bear application to the practise of medicine in the office and the home. The basic need is for the recognition by physicians that we are a long way from the discharge of our responsibilities when we lose interest at the moment the appendix comes out or the fever breaks. The physician must be concerned with the speed and efficiency with which his home-ridden patients are returned to useful social occupations. Hospitals can do nothing, even with the best of facilities, unless the physicians understand the reason for convalescence management and support its use. Basic research must be done, and new concepts and technic will emerge. The beginning must be made by education of the medical profession to one simple fact: *Your job isn't done until your patient's on the job.*

SUMMARY

1. A brief description is presented of the reconditioning activities developed in the armed forces.

2. Indication is made of the rationale for such program.

3. Possibilities are described for applying the principles of convalescence management to civilian hospitals.

4. The physician is described as having a permanent responsibility to his patients, before illness and injury for prevention, and after illness and injury for efficient convalescence and rehabilitation.

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Original Articles

EVALUATION OF COMMON PROCEDURES IN MAMMAPLASTY AND A NEW TECHNIC

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DURING and after the last World War there was a widespread popular curiosity concerning most of the sciences, particularly regarding subjects hitherto taboo or little known. The public interest, for example, in reconstructive surgery was heightened. The weakening of the Mrs. Grundy attitude of mind and the developments in reconstructive surgery, especially mammaplasty, were largely responsible for the present day increase in mammaplastic surgery.

An evaluation of the common technics seems necessary. These are: (1) Mammaplasty with free transplantation of nipple and areola; (2) two- and more-stage mammaplasties; (3) transposition ("buttonhole methods"); and (4) resection with transplantation of nipple and areola.

MAMMAPLASTY WITH FREE TRANSPLANTATION OF NIPPLE AND AREOLA

This technic was first described[1] in 1921 and published[2] in 1922 by Thorek. Dartigues[3] in Europe advocated the Thorek method. Axhausen[4] compared mammaplasty with free transplantation of nipple and areola to Lotsch's[5] technic (published in 1923). Weighing the advantages and disadvantages of the Lotsch transposition method and its possible complications (necrosis of nipple and areola) Axhausen discussed the Thorek technic, but was doubtful of the "take" of the freely transplanted nipple. Maliniac[6] challenged the possibility of "take" in a freely transplanted nipple. "The 'take' of a freely transplanted nipple," he wrote, "is technically impossible, as the ducts and muscle fibres will unavoidably slough." He came to the further conclusion that: "Mammectomy, as a plastic method for benign hypertrophy, is a crippling procedure injurious to the physical and mental health of the patient."

Thorek,[7] in rebuttal to this contention, furnished "indisputable histologic proof of successful taking of transplanted nipples, and the histologic presence of muscular, ductal, nervous, glandular and other normal components of the nipple." Thorek's re-emphasis of mammaplasty with free transplantation of nipple and areola popularized the technic.

Today certain indications for mammaplasty are widely accepted but two important factors have been given little consideration, for example, (1) A statistic survey of women operated upon for hypertrophy of breasts showed a ratio of 300 women at the age of sexual maturity to 2 women who underwent the operation after menopause. (2) During the last few years there has been a change in the age incidence of women undergoing reconstructive surgery of breasts. Prior to World War II the average age of women desirous of having a mammaplasty performed, ranged from the thirtieth to the fortieth year. A woman "disfigured" by childbirth and nursing usually postponed the operation until the children were no longer infants. At the present time the average age of

FIG. 1. Milk secretion from both nipples three weeks after mammaplasty (slanting technic).

prospective patients ranges between the twentieth and thirtieth year.

This incidence is explainable on the following basis: Women whose husbands were serving overseas decided (without consent of the husband) to undergo the operation. Women acquired independent incomes through work in war plants. They wanted to appear to the best advantage to the returning husband. The question of possible pregnancy rendering a mammaplasty inadvisable no longer required an answer. Reports of "miraculous achievements" in plastic surgery reached circles hitherto unfamiliar with the specialty. The competition of "sweater girls" and "pin-up girls" opened a frank discussion of breast contours. The pictures of South Sea Island beauties with conic breasts challenged the figure consciousness of "the girls left behind." Magazine articles on sex hormones still furthered figure consciousness.

Infant nursing, as is manifest to every one, is becoming more and more a lost art. Today some pediatricians favor the "milk formula" and often discourage healthy women from even attempting to nurse their baby. Esthetic considerations often enter here. The growing knowledge of the "milk factor" in development of neoplasms may perhaps justify the attitude of the pediatrician. It is also known that the milk producing function of hypertrophic breasts is almost nil.

The subconscious maternal instinct, of course, is unchangeable. One of the main questions asked by young women contemplating plastic repair of hypertrophic breasts, is invariably repeated as follows: "Can I nurse a baby after a 'breast plastic'"? And then hesitatingly: "If I want to, or if my doctor will let me."

The physiologic function of the breast (production of milk and its passage through the mammary ducts) is rendered impossible by all procedures which disconnect the mammary ducts within the nipple from the excretory ducts of the underlying acini. Even though "indisputable proof" has been furnished of the presence of muscular, ductal, nervous, glandular and other normal components of the nipple, the milk ducts leaving the acini (if any remain) cannot be reconnected with the ducts of the freely transplanted nipple. *No surgical procedure can accomplish this reunion.*

From the theoretic viewpoint, each mammary duct within the freely transplanted nipple can be kept open by insertion of fine tantalum wires. By connection with the corresponding excretory ducts of the underlying acini, the restoration of physiologic function is *imaginable* but technically impossible. Practically, however, the ducts of the acini can hardly be delimited during surgical procedures. Furthermore, from the theoretic viewpoint, the search for excretory ducts of the acini would take even the experienced surgeon many hours. The direction of the residual breast tissue after resection differs, moreover, from its original position, depending on the resection procedure used.

Thorek's term "mammaplasty with free

Fig. 2. Same patient as in Figure 1; lateral view.

Fig. 3. Complete necrosis of left nipple and incomplete necrosis of the left areola after transposition with resection of subcutaneous fat and lower pole of parenchyma. During subsequent pregnancy galactocele developed.

transplantation of the nipple" and Maliniac's "mammectomy with free transplantation of the nipple" have dissimilar meaning from the surgical viewpoint. In his first publication in 1922, Thorek[2] described "mammectomy" and not "mammaplasty." In his publication in 1945[7] Thorek revised his technic, to wit: ". . . after resection of the breast substance to the desired extent. . ." This implied "mammaplasty" with preservation of some breast tissue. He concluded: "The ideal results one aims to accomplish in plastic reconstruction of the breasts . . . they must be able to function (endocrinologically). Enough tissue is left behind in a properly performed reconstruction operation to assure endocrine function." The statement that "the newly reformed breasts must be able to function (endocrinologically)" must be evaluated as to its validity.

What is the endocrinologic function of the breast? The female breasts are considered skin glands containing fatty, connective and alveolar tissue. The mammary ducts, terminating in the nipple, are the ultimate exits of the excretory ducts of the acini. In the beginning of the menstrual cycle connective tissue responds to the stimulus of estrogens, while later proliferation of acini takes place through hormonal influence of the corpus luteum. Both tissues furthermore respond indirectly to hormonal stimuli of the hypophyseal and adrenal cortex glands.

The hormonal influence of the thyroid gland on the breast has been proved by administration of thyroid preoperatively solely for deficient milk secretion. (It is commonly known that the thyroid gland often becomes enlarged during pregnancy and returns to normal size after childbirth.) The breast, during pregnancy, similarly affects the adrenal gland as is shown by the increase of pigmentation within the areola.

From the aforementioned facts it can logically be deduced that the breast during pregnancy, either directly or indirectly, exerts a hormonal stimulus on other endocrine glands.

A theory has been propounded to the effect that breast tissue proper is an endocrine gland, producing a hormone which re-

FIG. 4. Unsatisfactory cosmetic result after two-stage mammaplasty. (First stage: transposition of nipple and areola with resection of subcutaneous fatty tissue; second stage: resection of parenchyma and excess skin in submammary folds.)

FIG. 5. Same patient after transplantation of nipple and areola with resection of parenchyma (slanting technic).

influences the hormonal cycle. All scientific reports in support of this theory are based on experimental work carried out on animals.

Geschickter[8] refers to the endocrine function of the breast as a one-sided response (connective and alveolar tissue) to the influence of ovarian, corpus luteum, and indirectly, hypophyseal and adrenocortical stimuli.

The following case history appears to add biologic and physiologic significance to the endocrine character of the breast:

A. H., thirty-two years of age, a white housewife, who had a normal childbirth ten years previously, suffered from hypertrophic pendulous breasts. She attributed alienation of husband's affection to this deformity. Mammaplasty was performed with the slanting technic. Metrorrhagia occurred immediately following return from the operating room. Menstruation lasted five days. The post-surgical period was uneventful. Three weeks after mammaplasty, milk secreted from both nipples. The subsequent menstrual period occurred four weeks after mammaplasty. Milk secretion ceased with the appearance of menstruation. (I have frequently observed that metrorrhagia occurs subsequent to mammaplasty. This can be considered as evidence of the endocrine nature of the breast itself. Admittedly, metrorrhagias frequently occur following any surgical intervention.)

A great number of patients suffer from metrorrhagia following mammaplasty. Surgical intervention apparently stimulates breast tissue to act as an endocrine gland. This stimulation primarily involves the menstrual cycle. In the particular instance previously mentioned surgical intervention furthermore stimulated the hypophyseal gland and its galactogenic hormone.

Surgical intervention, therefore, can be considered a hormonal stimulus similar to that of pregnancy. *The stimulated breast tissue acts as an endocrine gland.* This fact is of transcendent importance in regard to mammaplasty. The question may well be asked: How will the remaining mammary tissue function (endocrinologically) in examples of mammaplasty with free transplantation of nipple and areola? (In "mammectomy" resulting in breast-like formations of fatty and skin tissue, the hormonal stimuli will not find responsive tissue.)

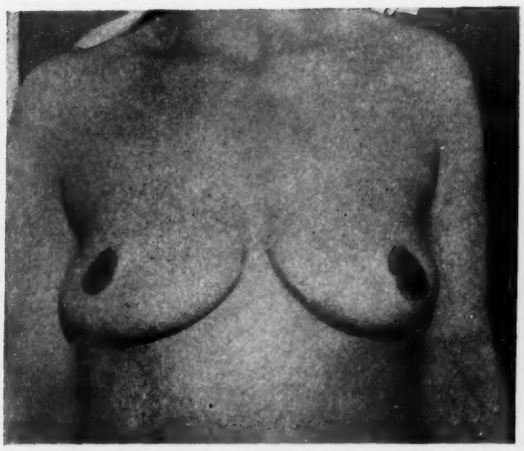

Fig. 6. Transposition of nipple and areola with resection of subcutaneous fatty tissue. (Note distortion of nipple and areola by traction of unsuspended parenchyma.)

Fig. 7. "Pancake-breast" resulting from transposition of nipple and areola with resection of parenchyma. Note extensive scars in submammary folds.

Residual breast tissue responds to hormonal stimuli. These stimuli, once established during adolescence, continue during sex maturity. It is commonly known that many women before menstruation complain of drawing sensations, swelling of the breasts and sometimes even a slight discharge from the nipples.

When pregnancy occurs hormonal stimulus is increased. The breast connective tissue proliferates, the acini enlarge in size and increase in number, and under the additional influence of galactogenic hormones, milk is produced and finally excreted through the mammary ducts.

I have never observed breast changes during pregnancy after mammaplasty with free transplantation of the nipples. But it is germane to report on two patients, seen in consultation, in whom pregnancy occurred after mammaplasty with subsequent necrosis of nipples.

CASE REPORTS

Case I. P. G., a twenty-two year old white, plump woman, married, had followed a rigorous diet of black coffee and cigarettes because her husband insisted that she become "streamlined." He was soon proud of her new silhouette, but disliked contours of her breasts which were disproportionate to her newly acquired contours. Mammaplasty was performed according to the modified Lexer-Kraske technic. Possibly due to secondary anemia, post-surgical complications—necrosis of both nipples and areolas—developed. After this marriage ended in divorce, the patient married again. The second husband insisted she become pregnant. Complications started during the third month of pregnancy. The patient complained of drawing pains in both breasts. Milk abscesses developed at the end of the fourth month. Surgical intervention was urgent. Additional milk abscesses developed and were treated surgically. At various periods artificial termination of pregnancy was contemplated, but the husband objected. Milk abscesses became more numerous and further surgery was found exigent. At the end of the eighth month albumin was found in the urine in increasing amount, and finally a cesarean operation was performed with blood transfusions.

Case II. L. F., a thirty-two year old white woman lawyer, suffered from enormous hypertrophy of both breasts. She was engaged for seven years but refused marriage because she was conscious of her deformity. Mammaplasty was performed (Lotsch transposition with resection of subcutaneous fat and lower pole of parenchyma). Primary healing of the right breast took place and there was a satisfactory cosmetic result. The left breast developed bluish discoloration with subsequent necrosis of nipple and areola. Several months later a secondary correction of the left nipple was performed by forming an artificial protuberance with subsequent tattooing. The patient married soon thereafter and became pregnant. At the beginning of the third month she complained of a drawing sensation in the left breast. In the fourth month a cyst-like formation ap-

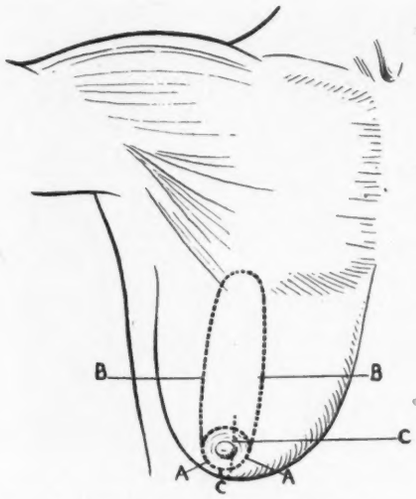

FIG. 8. A, skin incision around areola; B, arc-like skin incision to site of new placement of areola; C, vertical skin incision from middle areolar area to lowest margin of breast.

FIG. 9. Undermining of entire skin covering breast.

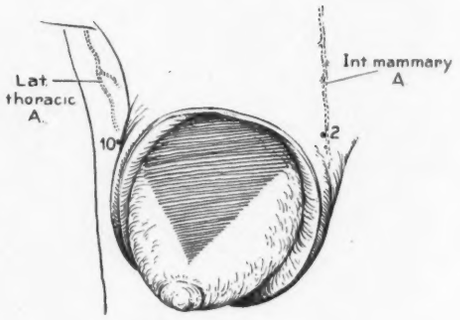

FIG. 10. Removal of wedge-shaped segment of breast tissue in upper quadrant of breast.

peared in the lower outer quadrant of the same breast. No chills, temperature or redness of skin occurred. Aspiration showed milky, butter-like contents. Diagnosis: galactocele.

Consultation was carried on with several specialists who concluded that roentgen-ray treatment was preferable to surgery. Six treatments were given following aspiration. Two weeks after the last roentgen-ray treatment the axillary glands became enlarged and sensitive. Lymphedema developed in the left arm without response to treatments. A spontaneous miscarriage occurred at the end of six months. There was a discharge from the right nipple for about six weeks with a drawing sensation in the left breast; the enlarged lymph glands in the left axilla and lymphedema of the left arm subsided in two weeks. The patient refused a second pregnancy, but developed a serious psychotic condition which was successfully overcome by adoption of a baby.

It may reasonably be argued that the histologic and pathologic pattern of breast tissue differs in examples of necrosis of nipple and areola from that of freely transplanted nipple and areola. Necrosis of the nipple nearly always involves destruction of underlying ducts, acini and connective tissue. Scar tissue often includes excretory ducts. Chronic mastitis in the adjacent area is not infrequent.

In the physiologic sense the condition present after mammaplasty with free transplantation of nipple and mammaplasty followed by necrosis of the nipple is the same. There is no outlet for the galactophorous ducts. The danger of hormonal stimulation as such and the increased stimulus during pregnancy and lactation is similar to that described in the previously mentioned case histories.

Mammaplasty with free transplantation of nipple and areola, performed on any woman during sex maturity, as advocated by Thorek and others, in my opinion, is dangerous and in contravention of modern concepts of hormonal physiology.

If hysterectomy with oophorectomy has deprived a woman of her gestatory function, or if mammaplasty is desired after menopause, the operation with free transplantation of the nipple may be considered. If during hysterectomy part of the ovaries remains, the residual breast tissue after mammaplasty with free transplantation of the nipple is still susceptible to hormonal stimuli.

Mammaplasty with free transplantation of nipples is definitely contraindicated for all women whose sexual maturity is not ended.

The differentiation between true hypertrophy (during the onset of adolescence or

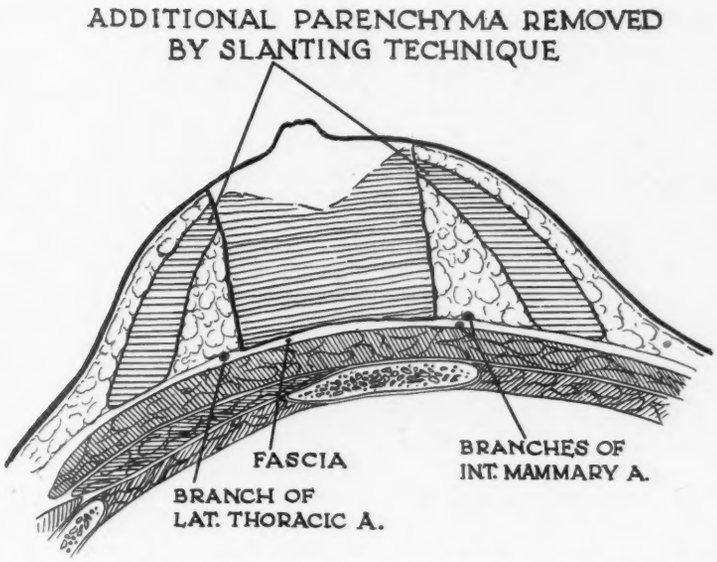

FIG. 11. Author's slanting technic for hypertrophic pendulous breasts.

early pregnancy) and excessive adiposity of the breast is important from the viewpoint of causative factors. But the surgical approach has no relation to the diagnostic differentiation. The surgical aim must be elimination of physical and mental suffering. "Mammectomy," comprising the resection of all breast tissue and formation of a breast-like appearance (consisting of fatty and skin tissue) is the simplest surgical technic. But "mammaplasty," with preservation of the smallest amount of tissue, able to respond to hormonal stimuli, is unsuitable for the aforementioned reasons.

Another important consideration is the danger of tissue damage induced by the response of residual breast tissue to hormonal stimuli after mammaplasty with free transplantation of nipple and areola. It must ever be borne in mind that *tissue damage is considered today as an important factor in the development of neoplasms.*

TWO- AND MORE-STAGE MAMMAPLASTIES

The grave complication of necrosis of nipple and areola in mammaplastic procedures was realized early in the history of reparative surgery. After Kraske[9] described his basic method of breast reconstruction with resection of breast tissue and transplantation of nipple and areola, many surgical complications were reported. Various suggestions were offered to eliminate the possibility of such complications.

In 1929, Schreiber[10] described a two-stage surgical procedure. In the first stage, resection of breast tissue with transplantation of attached nipple and areola, was carried out in the upper half of the mammae; in the second stage, after an interval of at least four weeks, glandular tissue was resected in the lower half of the breast and skin was adjusted to the new contours.

The two-stage operation was adapted by a number of surgeons because: (1) It preserved the blood supply by resection, in one stage, of a relatively small amount of breast tissue; (2) it preserved the subcutaneous arterial plexus which supplies nipple and areola; (3) it prevented shock following prolonged operating time and consequent prolonged tissue exposure, and (4) it prevented tissue necrosis by concentration of arterial blood supply in a limited area.

The same considerations were kept in view in another two-stage approach; the correction of one hypertrophic pendulous breast at a time, and a repetition of the procedure on the other breast after an interval of at least four weeks.

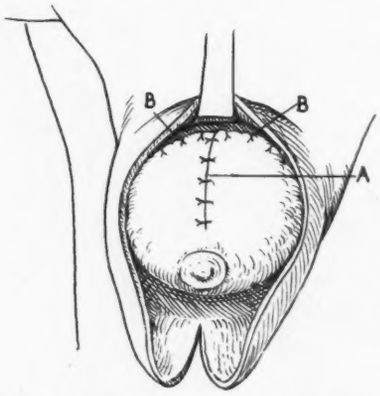

FIG. 12. A, interrupted sutures through entire breast tissue, following removal of wedge-shaped section; B, interrupted, suspension sutures connecting newly shaped breast to fascia of pectoralis major.

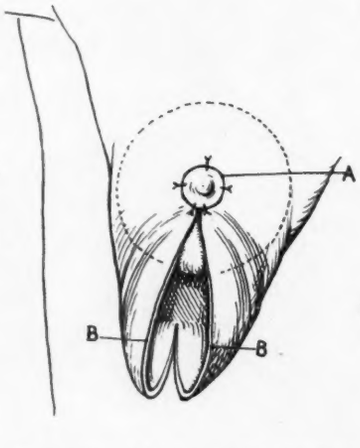

FIG. 13. A, skin replaced in original position and areola united by temporary, interrupted silk sutures; B, redundant skin in lower part of breast.

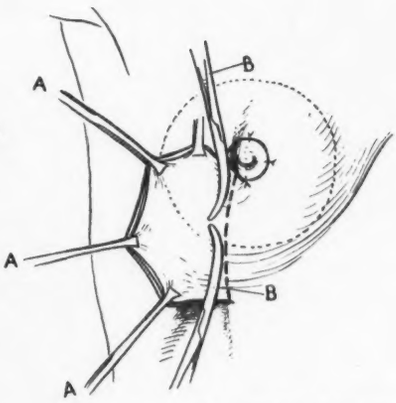

FIG. 14 A, redundant skin on both sides of original vertical incisional line, drawn forward above the reconstructed breast; B, curved Kelly forceps transfix redundant skin flaps.

The following case histories are perhaps of interest:

CASE REPORTS

CASE I. A. M., a twenty-five year old white woman, unmarried, whose previous history is irrelevant, enlisted in the WACS. She was always conscious of overdeveloped breasts and became more so in regard to the disproportions in a tight-fitting uniform. The surgeon suggested reconstruction of the right breast, to be followed four weeks later by that of left breast. Mammaplasty of the right breast was performed. The post-surgical period was uneventful. The result was satisfactory from a surgical and cosmetic viewpoint. The patient requested a second operation in a month but was then informed that physician was ill and could not perform a second operation before at least six months. She resumed her military duties ever conscious of artificial asymmetry of her breasts, which she could conceal only by placing cotton pads over the reduced breast and squeezing the unoperated breast into a tightly fitting brassiere. She received orders for overseas duty before the surgeon resumed his practice. She remained overseas for two years, acutely conscious of her deformity which she could not conceal from her associates under primitive camp conditions. The patient developed a psychoneurosis which she tried to overcome by meritorious war work. When she returned from war, she consulted another surgeon. Despite the successful outcome of the first operation, her inferiority complex and emotional reaction destroyed her confidence in the surgeon who performed the first operation.

CASE II. J. D., a twenty-eight year old white woman, who was a professional model, wore tight brassieres with resultant prolapse of both breasts. When strapless bathing suits and evening gowns became fashionable her professional earning capacity was reduced because of her pendulous breast condition. On consultation with a surgeon she was advised regarding the safety of a two-stage operation. The first operation was successful from a surgical viewpoint. (Incomplete resection of parenchyma in both upper breasts with transplantation of nipple and areola.) The patient was eager to return for a second operation. Unfortunately, her mother became ill and her earnings were spent in payment of hospital bills. Finally, she lost her job and was unable to hide her massive breasts even with clever contraptions. Economic circumstances worsened and the patient could not undergo a second operation. Five years passed until the patient saved enough money to pay the necessary expenses of a second operation.

Joseph[11] introduced an additional procedure—a three-stage mammaplasty—in order to prevent interference with the blood supply of the nipple and areola. In the first operation he resected a small

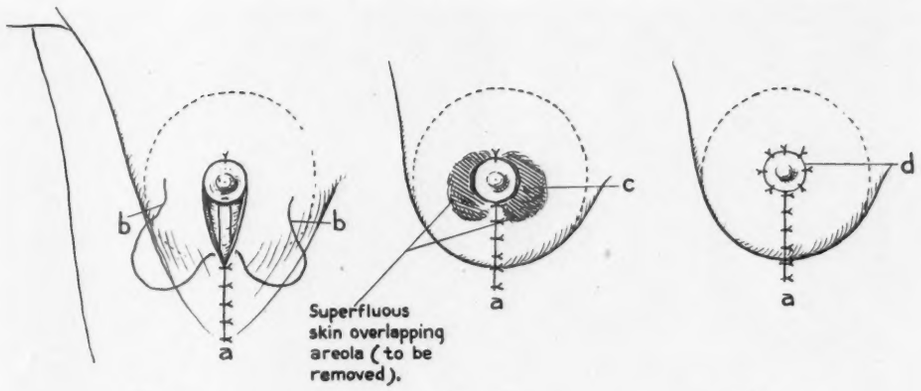

Fig. 15. Fig. 16. Fig. 17.

Figs. 15, 16 and 17. A, skin suture beginning at lowermost part of initial vertical incision; B, mattress suture, connecting uppermost point of vertical skin suture with lowest part of areola; C, redundant skin overlapping areola, following the insertion of mattress suture; excess skin is subsequently removed. D, final skin suture circumscribing areola.

amount of skin, subcutaneous and breast tissue above and below the nipple of one breast; in the second operation the same procedure was carried out in the other breast; in the third stage, about two months later, the excess tissue of the lower breasts was resected and the skin adjusted in the sub-mammary fold. (Maliniac[12] repeatedly emphasized the prevention of complications by a two-stage mammaplasty.)

The contraindications to two- or more-stage mammaplastic procedures are: (1) psychologic, (2) economic, and (3) esthetic, at times.

It is obvious that a healthy person dislikes to undergo a surgical operation. A woman suffering from hypertrophic pendulous breasts, however, will submit to *one* operation in order to have the deformity corrected. But the suggestion of a two-stage operation is discouraging and depressing. If she finally accepts the surgeon's advice concerning a two-stage mammaplasty, her psychosomatic condition may impair the primary healing. The possible shock produced by a second anesthesia within a short period makes her relatively unsafe for surgery.

The economic aspect of a two-stage mammaplasty is of equal importance. When only women of leisure and wealth underwent mammaplastic corrections, neither time nor money interfered with the surgeon's plans. Today, the average woman desiring mammaplastic reconstruction comes from a different stratum of society. She is usually employed. She is permitted a limited absence, and the mammaplasty must be completed within a limited period on limited finances. A second hospital expense often renders the desired "breast plastic" impossible. A second leave of absence may result in the loss of her job.

The esthetic advantages of a two-stage operation are questionable. The surgeon who specializes in mamma reconstruction, must not only be experienced in that field, but truly an artist as well. During and after the operation tissue changes take place which may vary in different areas and in different persons. A retromammary or lateral hematoma may form with congestion. The breast or breasts after the first stage seldom regain their final contours even after four weeks. This in itself may reveal asymmetry.

Where the term "two-stage mammaplasty" implies incomplete resection of both breasts in the first operation, the two breasts may present an asymmetric adjustment at the time of the second operation. The final result will be esthetically unsatisfactory.

In all examples of true hypertrophy or hypertrophic pendulous breasts of enor-

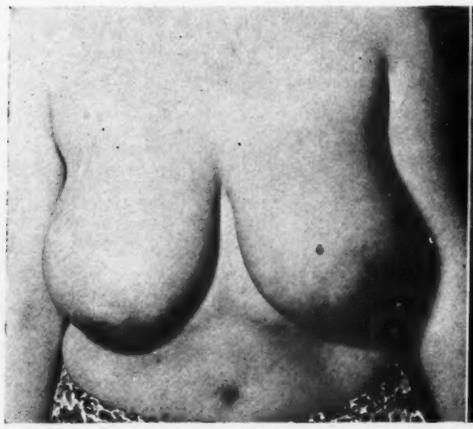

FIG. 18. Virginal hypertrophy (fourteen-year old patient).

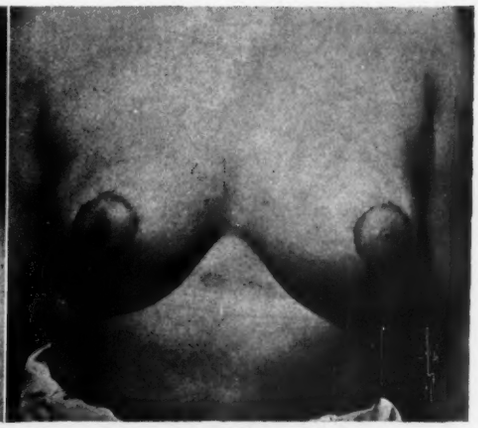

FIG. 19. Same patient as in Figure 18 after mammaplasty (slanting technic).

mous volume a two- or more-stage operation should be seriously considered as the procedure of choice. But where a medium degree of prolapse is present (the umbilical level may be considered as a dividing line) a one-stage operation can be performed successfully if hemostasis is thorough and infection avoided, and proper time-saving surgical procedures are utilized.

TRANSPOSITION OF NIPPLE AND AREOLA ("BUTTONHOLE" METHODS)

In 1923, Lotsch[5] described a technic of transposition of nipple and areola in which they remained connected with the underlying breast tissue and were transposed to the recipient area. After a vertical incision from the lowest point of the transposed areola into the submammary fold, additional skin wedges were resected on both sides of the vertical incision. Nipple and areola were therefore transposed into the desired location and prolapse of the skin was eliminated. No suspension of the breast itself was carried out. The entire support was based solely on the skin.

In the slightest degree of prolapse the parenchyma situated below the nipple is more voluminous than above the nipple. Without suspension a new ptosis is brought about in a short time.

In 1928, Lotsch[13] described a second transposition technic with simultaneous resection of subcutaneous fatty tissue along the entire surface of the mammary gland. The parenchyma remained undisturbed. The removal of excess skin was effected, not only in the aforesaid manner, but by additional resection in the submammary fold.

In examples of extreme hypertrophy, Lotsch also resected parenchyma by a horizontal excision in the lower pole of the breast.

It is evident that transposition of nipple and areola without resection of subcutaneous fatty tissue or breast tissue itself is only effective in atrophic pendulous breasts in which no reduction of volume is required.

Transposition of areola and nipple with simultaneous resection of subcutaneous fatty tissue or breast tissue is adequate where there is great hypertrophy.

From the cosmetic aspect the results of transposition methods without resection of fatty or breast tissue are unsatisfactory. The elasticity of the skin being reduced prior to reconstruction is inferior to the normal tonicity of breast skin. Even by slight increase in parenchymal volume ptosis recurs. The result is never permanent.

When the breast in its entirety is reduced in volume, the skin incision in the submammary fold extends medially to the sternum and laterally at least to the level of the transposed areola. The result is the so-called "pancake breast," with scars visible medially in a low-cut gown and laterally in a bathing suit or "halter." As the horizontal incision does not reunite the

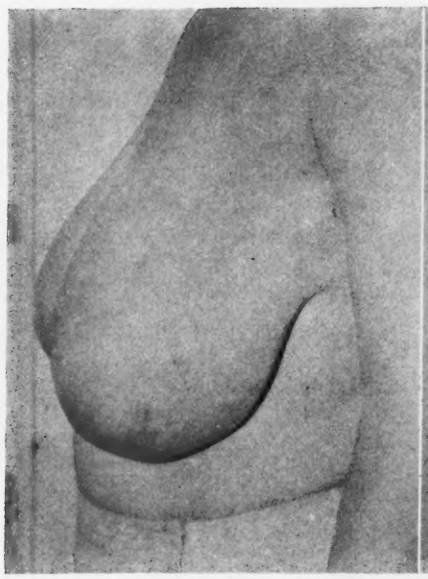

Fig. 20. Hypertrophic pendulous breasts.

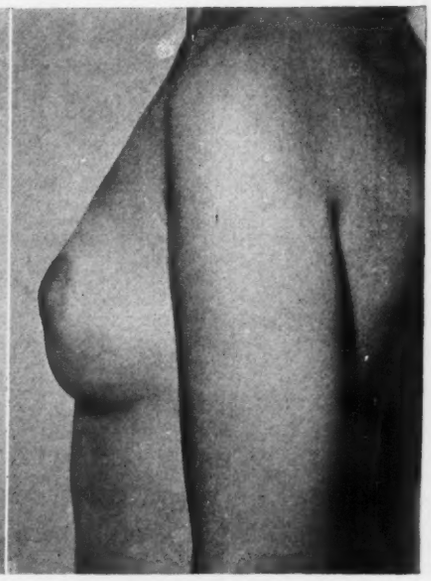

Fig. 21. Same patient as in Figure 20 after mammaplasty (slanting technic).

"Langer skin tension lines," it cannot fade into a mere hairline.

When ptosis of the breast recurs, after transposition with resection, the horizontal incision apparently moves upward and becomes wider by being actually drawn apart.

The parenchyma amassed below the nipple, without suspension will "pull" on the transposed nipple and areola and distort their direction. This distortion is apt to cause subsequent sloughing and necrosis of transposed nipple and areola.

RESECTION WITH TRANSPLANTATION OF NIPPLE AND AREOLA

The Lexer-Kraske[9] method is considered the basic procedure in modern mammaplasties. It consists of resection of breast tissue, including fatty, connective and glandular elements; formation of a normally sized breast proportional to the general configuration of the patient; suspension of the newly-formed breast on the fascia of the pectoralis major; transplantation of nipple and areola in the desired location; resection of excess, and adjustment of residual skin to the newly-formed breast.

In all methods of resection of breast tissue with transplantation of nipple and areola the most important consideration is:

Which part of the breast tissue should be resected?

In the original Lexer-Kraske method a section of the lower medial parenchyma was resected.

Biesenberger[14] resected the outer half of the mammary parenchyma including contiguous fatty tissue by an S-shaped excision, beginning in the axilla and extending to the lower pole of the mammary gland below the nipple and areola. The advantage of the S-shaped excision apparently lies in the preservation of blood supply in the immediate vicinity of areola and nipple. A second advantage is the resection of an equal amount of breast tissue above and below the nipple.

The S-resection preserves the internal mammary artery, while in even slight degrees of hypertrophy the lateral thoracic artery is injured or severed. The perforating branches of the intercostal arteries supplying nipple and areola remain intact.

After reduction of the breast parenchyma and suspension of the newly-formed breast on the fascia of the great pectoral muscle excess skin is removed not only by wedge excision lateral to the vertical incision but by an additional horizontal excision within or below the submammary fold.

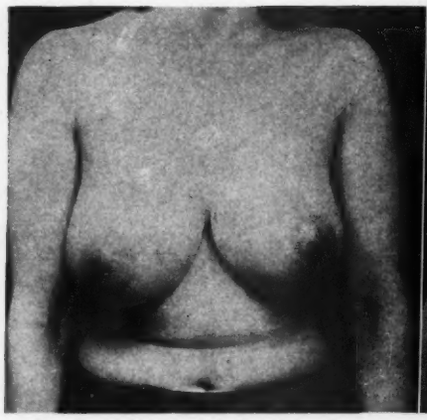

FIG. 22. Asymmetric hypertrophic breasts.

FIG. 23. Same patient as in Figure 22 after mammaplasty (slanting technic).

The danger of the Biesenberger modification, especially so in heavy, pendulous breasts, is the elimination of important arterial blood supply and the direction of the approximation of remaining breast tissue. This approximation is accomplished by raising the lower lateral to the upper medial wall of the residual parenchyma. The union is approximately above the internal mammary artery.

Obstruction of the lateral thoracic and congestion of the internal mammary arteries may impair the blood supply in this area. The entire parenchyma is distorted, and the excretory ducts of the acini are diverted from their normal directions. Nipple and areola, too, connected with the residual breast, are deranged in order to fit the newly-formed breast.

A second disadvantage of the Biesenberger modification (as in the original Lexer-Kraske method) is the removal of excess skin within or below the submammary folds. The skin incision, similar to the Lotsch transposition method with resection of tissue, reaches medially to the sternum and laterally either to the border area of the serratus anterior muscle at the level of the areola or, if carried out in straight horizontal direction, to the lower lateral aspect of the thorax. This extended scar is not in conformity with modern esthetic requirements.

From the surgical viewpoint, the obstruction of the lateral thoracic artery, the distortion of breast parenchyma and derangement of nipple and areola may induce congestion, resulting in sloughing and necrosis of parenchyma and of the areola and nipple.

Many other modifications of resection with transplantation of areola and nipple have been advocated.

AUTHOR'S TECHNIC

The two basic aims in mammaplasty are: (1) surgical safety and (2) satisfactory cosmetic result. Apart from a surgeon's possible inexperience and inefficiency failures in mammaplasty are due in most instances to complications arising during or after the operation.[15]

Manifestly that part of the parenchyma should be resected which is subjected to the greatest degree of damage. *This is the breast tissue situated in the upper medial quadrant above the nipple.* The connective tissue within this area loses its elasticity due to the steady "drag" of the hypertrophic parenchyma. The alveolar tissue degenerates owing to the same cause. The excretory ducts are elongated and collapsed. The arteries are stretched. The vein valves are defective. Superficial venous anastomoses appear as heavy cords within the atonic skin. Striae are further evidences of the "breakdown" of subcutaneous elastic tissue. The lymphatics are congested. The area in question, weak in its various components, is unsuitable for the formation of

Fig. 24. Lateral view.

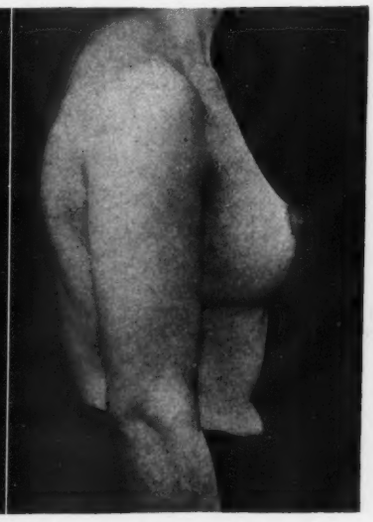

Fig. 25. Same patient as in Figure 24 after mammaplasty (slanting technic).

a "new" breast, and even more so as a base for suspension. The damaged tissue carries in itself potentialities of development of neoplasms. For the aforesaid reasons parenchyma must be resected in the *upper medial area.*

The internal mammary artery usually enters the posterior aspect of the mamma in the two and two-thirty (clockwise) area. The lateral thoracic artery enters between ten and ten-thirty. Resection of parenchyma between these "figures" does not interfere with the main blood supply. It will definitely eliminate the "weakest" tissue.

In hypertrophic breasts the skin incision encircling areola and nipple is restricted to the epidermis. A parallel incision is carried out one and one-half inches distant from the first and extended to the anterior ligament of Cooper. The undermining of skin is effected by blunt gauze dissection. Undue injury to the tissue is avoided and surgical bleeding is eliminated.

Large arteries, of course, must be carefully clamped before surgical severance. Thorough hemostasis is an absolute requirement. When oozing cannot be controlled by suture ligatures, local use of coagulants is advisable. Vitamin K is indicated in excessive bleeding during operation.

Where extreme hypertrophy is not adequately reduced by resection of breast tissue between ten and two (clockwise), the resection must be extended medially and laterally, depending on the excess volume of parenchyma. This additional resection should be effected in a *slanting* direction, starting at both walls of the separated parenchyma and passing downward to the extreme border of the area to be excised. By this "slanting technic" only the terminal branches of the internal mammary and lateral thoracic arteries can be severed, while the main arterial trunks remain intact.

The union of residual parenchyma must be firm. Internal and external rows of catgut sutures insure complete closure. At the same time the desired fullness of parenchyma above the nipple is obtained by a wider margin of the posterior and a narrow approximation of the anterior, areas.

Immediately on suturing areola and nipple into the previously excised skin arc, they are covered with alcohol-saturated gauze. When nipple and areola appear "pallid" or "bluish" during the operation, repeated alcohol applications produce hyperemia and thereby restore normal color.

The removal of excess skin is carried out on both sides of the vertical incision. The symmetric adjustment of the skin covering

the newly-formed breast is established before resection of the skin flaps.

Subcuticular and intracuticular catgut sutures are used for the approximation of skin borders. Final skin suturing is begun at the lowest point of vertical incision and continued upward (silk sutures).

After the vertical skin suturing is extended in length one-quarter of an inch less than the distance between the upper margin of the breast and the highest point of the transplanted areola, a mattress suture is placed between the last vertical suture and the lowest point of the areola.

Skin, now overlapping the medial, lateral and lower borders of the areola, is resected circularly. The circumference must be of equal distance or slightly less than that of the transplanted areola, because undue stretching of areola and nipple may impair the blood supply. Removal of excess skin within or below the submammary fold is consequently superfluous.

By resection of parenchyma in the upper and vertical removal of excess skin in the lower part of the breast, the inner and outer surgical fields do not overlap.

Primary healing of both fields is secured by separate blood supply.

The cosmetic appearance following this technic is superior to all procedures resulting in extensive submammary scars.

The patient must furthermore receive the benefits of the latest medical advances, for example, correct premedication is essential. Forty thousand units of penicillin are administered intramuscularly three hours prior to operation. Ten thousand units are given every three hours for three days following operation. (Penicillin not only prevents post-surgical infections but reduces the so-called normal post-surgical absorption temperature.) The choice of the proper anesthetic and of an expert anesthetist are of the highest importance. The emotional status of the patient, her habits (cigarettes, liquor, sedatives, stimulants) must be taken into consideration. An experienced assistant is of paramount importance for a speedy surgical operation. In all examples of mammary hypertrophy 5 per cent glucose in normal saline solution is administered intravenously during the operation. In post-surgical anemia blood transfusions and concentrated liver injections are of considerable value for general "reconditioning" and primary healing.

CONCLUSIONS

1. Mammaplasty with free transplantation of nipple and areola may be considered only after menopause.

2. Mammaplasty with free transplantation of nipple and areola during sex maturity is contraindicated.

3. Mammectomy with free transplantation of nipple and areola is a simple and safe surgical procedure in true hypertrophy and in enormous adiposity of breasts.

4. A two- or more-stage mammaplasty is often contraindicated for psychologic, economic, and possibly esthetic reasons.

5. Transposition of nipple and areola is effective only in atrophic pendulous breasts. The result is not permanent.

6. Transposition of nipple and areola with simultaneous resection is unsatisfactory. The result is not permanent; the scars in the submammary fold are not in accord with modern esthetic standards.

7. All transposition methods produce unsatisfactory and unsightly results, known collectively as the "pancake breast."

8. Resection with transplantation of nipple and areola is surgically safe and esthetically satisfactory.

9. Hypertrophic parenchyma must be resected in the upper medial part of the breast.

10. When resection between internal mammary and lateral thoracic arteries is adequate, no interference with the blood supply can occur.

11. If additional resection of parenchyma is necessary, the "slanting excision" fully preserves the blood supply of the internal mammary and lateral thoracic arteries.

12. The final skin adjustment is restricted to the vertical mammary line below the areola.

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Chronic cystic mastitis is believed to be due to relative excess of the estrogens, producing abnormal duct proliferative activity. While estrogenic treatment has geen generally recommended, it does not seem rational unless the dosage is sufficiently large to bring about pituitary inhibition.

From "Textbook of Gynecology" by Emil Novak (The Williams & Wilkins Company).

WAR WOUNDS OF THE ABDOMEN

A REVIEW OF 131 CASES

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MODERN war, with the tremendous concentration of fire power that has been developed on the ground and in the air, has decreased the chances for survival of the soldier who is exposed to it in the front line for any length of time. In the infantry units kept in combat continuously over any period of time so many junior officers were killed that battlefield commissions were given to non-commissioned officers on very frequent occasions. These came to be looked upon gloomily as being tantamount to a sentence of death.

The soldier who was hit by a missile and survived to reach a hospital in World War II, however, had a better chance for survival than was the case in any previous war. This statement seems to be as true for abdominal wounds, with which this report is concerned, as it is for wounds in general.

Before World War I, conservative treatment was generally advised for gunshot wounds of the abdomen. In the Civil War there were 3690 recorded cases of abdominal wounds with a mortality of 90 per cent. In the Spanish-American War, there were forty-four cases reported, of which four were operated upon and all four died. Of the remaining forty that were treated conservatively, twenty-five died, a mortality rate of 62.5 per cent. In the Boer War (1900) and the Russo-Japanese War (1904-1905), the treatment was by starvation and large doses of morphine.[16]

Because of such reports, the surgeons in the early days of World War I were of the opinion that practically the only patients who recovered were those who were not operated upon. However, there were some reports from civil life that were more favorable. Grant, in 1899, collected 253 civilian cases of gunshot wounds of the abdomen in which operation was carried out with a mortality rate of 52 per cent.[8]

From 1857 to 1893, a series of tables of the reported cases of laparotomy done for gunshot wounds of the abdomen was compiled by various authors. In the first series, compiled by Morton, eighteen of the twenty-two laparotomies had been done by Americans. Sir William McCormac who also published a series of collected cases in 1887 perhaps gives a reason for this and reflects the British conception of Americans of that day when he says that gunshot wounds of the intestine are "far from being rare in civil practice, especially in America where everyone carries a revolver and often uses it on small provocation." Be that as it may, the introduction of laparotomy for bullet wounds was definitely an American contribution to surgery.[16]

Early in the first World War, Leriche[13] reported that the mortality in abdominal wounds with conservative treatment was over 80 per cent and advised early operation. In 1916, Wallace[21] reported on 1,200 cases of gunshot wounds of the abdomen among the British Expeditionary Forces. In this group the mortality of the operative cases was 53.9 per cent, not very much less than the total mortality of 60.2 per cent which included the non-operated cases. In 1917, Lockwood and Kennedy[14] reported on 500 cases seen in an advanced casualty clearing station. There were 356 operative cases with a mortality of 51.7 per cent.

Reports in the literature from 1924 to 1943 of a series of civilian cases give operative mortality rates of 48.2, 68, 59.3,

61.4, 53.4, 40, 60.5, 48.9 and 46.4 per cent. Thus it can be seen that the average reported mortality rate for gunshot wounds of the abdomen in civil practice between the two wars was around 50 per cent.[5,6,9,15,16,17,18,19,20]

Jolly,[12] who operated upon 970 patients with abdominal wounds in the Spanish Civil War of 1936–1939, probably the largest number ever done by an individual surgeon, reported that of 238 cases with injured viscera operated upon, 115 died, a mortality rate of 48 per cent. The rate for his colon wounds was about 60 per cent. He had no sulfonamides or penicillin and did not use gastric suction or the Miller-Abbott tube. He also makes no mention of the procedure of exteriorization for wounds of the colon, either suturing them or doing resections "in spite of the appalling mortality rate."

Reports of the surgical results in gunshot wounds of the abdomen in World War II indicate that a substantial reduction in mortality has been accomplished.

The 131 patients with abdominal wounds, which form the basis of this report, were operated upon by the writer. There were twenty-eight deaths, giving a mortality rate of 21.3 per cent. There were 115 cases which were found upon exploratory laparotomy to have injury to the viscera, and twenty-seven of these died, a mortality rate of 23.4 per cent for those having visceral injuries. Sixteen cases were explored without finding any visceral injury, and one died, a mortality of 6.2 per cent.

The patients operated upon were under the writer's observation for at least seven to ten days postoperatively in most cases before being evacuated to the rear, and experience has shown that in most cases they have either died or are on the road to recovery by the end of this postoperative period. Undoubtedly, there would be some increase in the mortality rate if every one of these patients could be followed through to the end but it would not be great.

Confirmation of this is found in a recent report by Fox[7] on 270 cases of thoracoabdominal wounds treated at a General Hospital. These patients had been evacuated to the General Hospital after undergoing surgery in forward hospitals. Seven patients of the series died, a mortality rate of 2.6 per cent. An indication of the definitive nature of the surgery done in the forward hospitals is the fact that 43 per cent of the patients required no further surgery at the base hospital; 36.3 per cent required only secondary wound closure or skin grafts.

The 131 patients discussed here were operated upon by the writer while he was Chief of a general surgery team of the 4th Auxiliary Surgical Group with the Third Army in the European Theater of Operations. Almost all of them were operated upon in Field Hospitals, the most forward installations where definitive major surgery was performed, the rest in Evacuation Hospitals.

An Auxiliary Surgical Group consisted of surgical teams, e.g., general surgery, thoracic surgery, orthopedic surgery, neurosurgery, maxillofacial, etc., as well as shock teams. A general surgery team in the 4th Auxiliary Surgical Group consisted of a surgeon, an assistant and an anesthetist, a nurse and two enlisted men. As a rule, the general surgery teams were assigned to Field Hospitals while the others worked in Evacuation Hospitals.

Field Hospitals were small surgical hospitals which could accommodate up to seventy-five patients at a time if necessary. The medical personnel of these hospitals were usually not surgeons and were concerned primarily with the administration of the hospital and pre- and postoperative care of the patients under the supervision of the attached surgical teams. The latter were in charge of preoperative, operative and postoperative care of patients. Decisions concerning evacuation of patients was also the responsibility of the surgical teams.

The Field Hospital was attached to the Divisional Clearing Station and was usually set up near or alongside it. During

combat, it received "non-transportable" cases from the clearing station. These were defined as sucking chest wounds, chest wounds with concealed hemorrhage or tension pneumothorax, abdominal wounds with any suspicion of peritoneal penetration and cases with hemorrhage or shock.

The Field Hospital, also, was the most forward installation where whole blood was available for transfusion. During periods of stress when a "back-log" of unoperated cases had developed, whole blood transfusion would relieve hemorrhagic shock and make a case transportable to the rear, if it were not a thoracic or abdominal case.

These hospitals functioned at varying distances from the front lines, sometimes as near as 1,000 yards and occasionally ten to fifteen miles distant, and usually within range of enemy artillery. In accordance with the policy of the Army Medical Corps of "taking the surgeon to the patient," the hospitals had to move frequently and were quite adaptable. Thus, they could function in tents or in almost any type of building or a combination of the two. During the campaign in Normandy, the Brittany peninsula, and northern France, until the middle of December, we operated in tents almost entirely. In Germany and Austria, buildings were usually used and it was found that a satisfactory operating room could be set up in such diverse places as a bier stube, a telephone exchange, a schoolhouse or hotel.

PREOPERATIVE CARE

The preoperative ward of a Field Hospital presented the ultimate picture of the waste of human life and suffering caused by war. When the fighting was intense, the casualties might pour in and a chaotic condition result, causing delay in proper pre- and operative treatment, unless a routine for the preoperative treatment was organized. Experience showed that the use of shock teams was the best way of dealing with this phase. These teams consisted of a medical officer, a nurse and two enlisted men.

When the seriously wounded were brought in they were usually exhausted, very dirty, their clothes torn and mud covered, their faces blackened with gunpowder, dirt and blood. They might be cold and wet. Many of them had been lying in the open in the rain or snow. They might have been carried across a river in a boat, followed by a rough ambulance ride under fire. They were apt to be in intense pain. Respiration might be painful. Many were very young and were frightened. Nearly all of them were suffering from some degree of shock.

The first thing to be done for the patient was to make him dry and warm. The clothing was cut away, moving the patient as little as possible while this was done, and blankets were put under and over him. He was kept on a stretcher which was placed on a cot. Keeping him on a stretcher enabled him to be carried to *x*-ray and to the operating room without moving him. He was also operated on while still on the stretcher.

The Emergency Medical Tag was inspected to see what the diagnosis was and what the previous treatment had been. It was checked to make sure that he had had his "booster" injection of tetanus toxoid, the amount of plasma that had been given, and, very important for the surgeon, how much morphine he had had and when. In the meantime, the initial blood pressure and pulse readings had been taken. Treatment for shock was then instituted, consisting of the intravenous administration of blood and plasma.

The patient's wounds were then inspected and it was very important, if his condition permitted, to turn him over and look at his back and, in fact, inspect him minutely from head to foot, for the Emergency Medical Tag could be in error as to diagnosis and a wound might have been overlooked. Frequently, the smallest wound was the most serious.

All dressings were removed so that the wounds could be thoroughly inspected. The writer has seen a wound covered up by

a strip of adhesive tape which was holding a dressing on another wound, thus explaining a puzzling absence of a missile on the *x*-ray film.

All patients with any possibility of an abdominal wound were catheterized and the urine examined grossly, and microscopically if possible, for blood, to rule out injury to the urinary tract. The abdomen was examined carefully in all cases. In any wound of the chest, the missile may have traversed the diaphragm to enter the abdomen and the opposite is also true. Frequently, abdominal tenderness and rigidity are present in chest wounds simulating an intra-abdominal penetration which is not present.

The treatment of shock is the primary consideration in getting patients ready for operation. The blood pressure and pulse are the most reliable guides and were checked frequently. A systolic blood pressure which was brought up to 100 or over and maintained, with slowing of the pulse, was the usual goal before operation.

Early in the war it had been hoped that the use of plasma would be successful in combatting shock from war wounds. It had been advised that if whole blood were used it could be given in the ratio of 2 or 3 parts plasma to one part blood. Experience in the Normandy campaign soon showed, however, that plasma was ineffectual in hemorrhagic shock. Transfusion of whole blood, and in adequate amounts, was necessary to bring patients to a condition to withstand surgery and to support them during and after operation. There can be no rule as to the amounts necessary. The amount necessary means just that, and it depends upon the individual patient.

Whole blood in amounts up to 5,000 and 6,000 cc. has been given with beneficial results. Whenever the tactical situation was such that blood could not be obtained it was immediately reflected in continuing shock, inability to get patients in shape to withstand surgery, and inevitably in increased mortality. Type "O" whole blood flown from the United States was given without cross-matching in most instances. Reactions to transfusions in the form of chills were frequent but the writer saw no deaths that could definitely be ascribed to transfusion reaction. There is no doubt, however, that they did occur, judging from personal communication with others.

Plasma had frequently been administered at the Battalion Aid Station, Collecting Station, or Clearing Station before the patient arrived at the Field Hospital. There is no doubt that it was useful. It tided the patient over until he could receive blood and in the milder cases it was all that was necessary, and thus saved blood.

While this shock treatment was going on, the patient was started on sulfadiazine and penicillin. Sodium sulfadiazine was given intravenously every eight hours and penicillin every three or four hours. A Levine tube was inserted into the stomach and Wangensteen suction applied.

As soon as the patient's condition warranted it, he was taken to *x*-ray and anteroposterior and lateral *x*-rays were taken. In all abdominal wounds, films were taken of the chest, as well as of the abdomen, and vice versa. Much useful information was obtained from these *x*-rays. The position of the missile or missiles was located and this knowledge, in combination with the position of the wounds, gave the surgeon a fairly accurate idea of the path it had taken and the organs that were probably injured. It also frequently settled the question of whether or not a thoraco-abdominal wound was present.

The transporting of the patient to and from *x*-ray, together with moving him for positioning while the films were taken, frequently resulted in lowering the blood pressure and increasing the pulse rate, and further shock treatment was necessary before he was considered in optimum condition for operation. Once this optimum period had been reached, however, the operation had best be carried out as soon as possible, for if the patient slipped down into shock again it would be difficult

or impossible to bring him out of it a second time.

OPERATIVE TREATMENT

The patient was brought to the operating tent or room and the stretcher placed on a saw-horse which worked quite well, or if an operating table was used, wooden blocks held the stretcher in place. In most cases the Levine tube was kept in place so that gastric suction might be started immediately postoperatively, and usually did not interfere with the administration of the anesthetic.

Gas-oxygen-ether was used on all abdominal cases, given by the closed system. In cases in which the chest was also involved, intratracheal anesthesia was always used, and it was also used in many of the purely abdominal cases as well.

Electric current was furnished by portable gasoline generators. The operating room lights were "home-made" and of various types, limited only by the ingenuity of the personnel of the hospital. One successful kind was made from headlights salvaged from crashed airplanes, attached to a quadrangle or triangle of wood, and could be moved to focus on the operative field. When the lights went out from the concussion of bombing or other circumstances over which we had no control, flashlights were focussed on the operative field by someone standing by and the operation proceeded.

Many of the patients were in very desperate condition when brought to the operating room in spite of energetic preoperative treatment. This was usually due to very extensive intra-abdominal injuries or multiple injuries, or to continuing hemorrhage. When it was decided that no further improvement could be obtained by anti-shock therapy, they were operated upon if at all feasible, offering the only chance for survival. Some did not, of course, survive, but there were others that seemed hopeless at the time of operation but surprised everyone by pulling through.

Wounds of the back were usually débrided first so that the patient would not have to be turned for this purpose at the end of a long operation. By the same token, if the patient was in poor condition after an abdominal operation and it was judged he would not stand further procedures on other multiple injuries, such as compound fractures of extremities, these were put in traction or plaster splints and débrided at a later date.

If a thoraco-abdominal wound was present and thoracotomy was necessary, this was usually done first and the laparotomy second, if the necessary procedures could not be done through the thoracotomy incision.

The type of incision used was based on the position of the wounds and the *x*-ray findings. Transverse and subcostal incisions were frequently employed and found very useful. Rectus incisions were of the split muscle type. Mid-line incisions were made in a few instances. In exploring an abdomen for a gunshot wound, it is absolutely necessary to inspect thoroughly every organ in the peritoneal cavity. This is especially true when the victim has been struck by several fragments. In order to do this an adequate incision must be made. The poor lighting under which most of this work was done also made fairly long incisions necessary. Usually upon opening the peritoneum, the cavity was found filled with blood clots and frequently gross feces. We usually had suction, sometimes made available by placing a truck with its motor running outside the tent and running a tube to the windshield wiper.

After sucking and mopping out the peritoneal cavity, active bleeding was looked for. Then the small intestine was inspected in its entirety and all perforations tagged with clamps. The small intestine was then eviscerated while the other organs within the peritoneal cavity were inspected. This is an important time-saving procedure and here again an adequate incision is necessary or the small gut will become markedly congested while it is being held outside.

Injuries of the large bowel may be very deceptive and hard to find, and it is absolutely imperative that the operator be sure whether or not there are any perforations in it. Lacerations of the mesenteric border and retroperitoneal lesions must be searched for, if suspected; and it may be necessary to mobilize a considerable portion of the bowel to find the lesion or convince oneself that there is none present. The writer has noted on several occasions when a retroperitoneal hematoma was present, the presence of emphysema under the peritoneum, lateral to the descending or ascending colon, probably due to colonic gas, which has led to the discovery of a retroperitoneal laceration of the large bowel.

When a penetrating wound of the anterior wall of the stomach is present, the gastrocolic omentum should be incised and the posterior wall inspected. If there is still doubt, an anterior gastrotomy may be done and the missile searched for within the lumen of the stomach.

In any instance in which the retroperitoneal spaces have been opened in the presence of contamination, they should be drained posteriorly through a stab wound. This is also true of kidney or ureteral injury when a nephrectomy has not been done.

Injuries of the colon were treated by exteriorization in nearly all cases. Small intestinal injuries were repaired if at all possible. If not, resection and primary anastomosis was done, usually end-to-end.

Injuries of the infra- and retroperitoneal portions of the rectum are very serious unless treated properly in the beginning. The diagnosis may be made by digital examination, proctoscopy or deduced from the course of the missile. Usually it is necessary to perform an exploratory laparotomy, at which time a colostomy is done. The patient is then turned over and a coccygectomy done, the fascia propria incised and the whole retrorectal space widely opened and drained. If the laceration is seen, it should be repaired. All colostomies should be made through separate stab wounds if possible and time permits.

Wounds of the liver had usually stopped bleeding when the abdomen was opened. If bleeding was present, it might be necessary to pack the liver. Lacerations of the liver were usually not sutured. It was believed that drainage of bile and necrotic liver tissue from the tract would be blocked by suturing. It is better not to suture the liver but to place drains down to the liver lacerations to give egress to bile and prevent the formation of bile peritonitis and bile cysts.

Lacerations of the duodenum are difficult to repair and are usually associated with other grave injuries. The duodenum must be mobilized adequately to get at least a two-layer closure, preferably three.

Lacerations of the gallbladder were treated by cholecystostomy as there were other injuries to be taken care of, and it is simpler and quicker. The writer saw one case of laceration of the gallbladder with other visceral injuries which also had an anterior perforating ulcer of the second portion of the duodenum, which had perforated to, but not through, the peritoneum.

Extreme conservatism was used in treating wounds of the kidney. Nephrectomy was done only when the kidney was grossly fragmented or there was continued bleeding from the renal vessels. Extraperitoneal drainage to the kidney area was provided through a flank incision. It was believed that by this policy many kidneys were saved, and that if nephrectomy was necessary, it could always be done later.

Bladder wounds were treated by doing a suprapubic cystostomy and suturing the lacerations. Occasionally, the bladder was injured entirely extraperitoneally, and no injury would be seen at laparotomy. Here the course of the missile, plus the presence of blood in the urine, will prompt the operator to search for a bladder laceration. When comminuted fractures of the pelvis are present, bone fragments may be in the bladder and other sharp fragments may be

impinging on the bladder or be sticking part-way through the bladder wall. These should be removed and the bone made smooth. After the bladder had been cleared out and the lacerations sutured, the cystostomy opening was closed about a mushroom catheter and the prevesical space was drained.

At the close of abdominal operations where there had been intestinal injuries with contamination, 5 gm. of sulfanilamide, mixed with 100,000 units of penicillin powder, was dusted into the peritoneal cavity and the layers of the abdominal wall. No intraperitoneal drainage was used except in the presence of liver, pancreatic and duodenal injuries.

All entrance and exit wounds were thoroughly débrided and loosely packed. The abdominal incisions were closed in layers. The peritoneum was closed with a single running catgut suture. Tension sutures of heavy silk were then inserted through all layers, including a bite of the peritoneum. The fascia was closed with interrupted chromic catgut sutures. The skin was then closed or not, depending upon the degree of contamination. In the presence of fecal contamination, the wound was packed to the fascia with vaseline gauze, and the tension sutures tied over it.

Infection was certainly not a factor in the postoperative course of the great majority of these patients while under observation in Field Hospitals. Little or no evidence of postoperative peritonitis was observed in nearly all the autopsies seen by the writer upon patients who died from a few days to two or more weeks after operation in which fecal contamination had occurred. The chemotherapy used in the whole course of the treatment seems to be the major factor in producing such amazing results. I would add that penicillin seems to be the most important single factor. Other surgeons have reported similar results with the use of penicillin alone, the sulfonamide drugs not being used at all (personal communication).

POSTOPERATIVE CARE

At the end of the operation the patient was sucked out with an intratracheal catheter, if necessary, until dry and taken to the postoperative ward. He was not moved from the stretcher. The operative procedure had frequently been long and it was necessary to observe the patient closely in the immediate postoperative period. Oxygen was given frequently, usually by nasal catheter. Wangensteen suction was applied. Frequently blood was given. Occasionally, a patient would lapse into secondary shock. Concentrated serum albumin was found to be useful in this emergency, although it was often not available. Patients with chest wounds were put in a sitting-up position when possible.

Parenteral fluids were given, a minimum of 3,000 cc. a day, until the patient could take fluids by mouth. These fluids consisted of 1,000 cc. of plasma, 1,000 cc. of physiologic saline, and 1,000 cc. of 5 per cent glucose in distilled water. Fluids lost by gastric suction were replaced by intravenous saline. Whole blood was given when indicated and was very useful to give the patient a boost several days after the operation. It was surprising how many of the patients responded promptly postoperatively. Illustrative of this was one early in our experience who had had a lacerated stomach and small intestine with a very massive intraperitoneal hemorrhage who complained bitterly twenty-four hours after he had been operated upon because he was not allowed to get in the "chow line."

The Influence upon Mortality of the Time Interval between Wound and Operation. (Table 1.) The average time interval between wound and operation was 9.7 hours and ranged from two hours to four or five days. Table 1 shows the mortality rates for the 121 cases in which the time factor was known and these are compared with rates for similar intervals in cases with hollow viscus perforation. The difference is not very great and bears out the impres-

TABLE I

TIME INTERVAL BETWEEN WOUND AND OPERATION
121 CASES IN WHICH THE TIME INTERVAL IS KNOWN

Hours	All Cases				Cases with Hollow Viscus Perforations			
	No. of Cases	Incidence	Deaths	Mortality Per Cent	No. of Cases	Incidence	Deaths	Mortality Per Cent
1–4	12	9%	0	0	6	6.9%	0	0
4–8	44	36%	10	22.7	32	36%	7	21.5
8–12	36	29%	10	27.7	25	28%	9	36
12–18	17	14%	2	11.7	12	13%	2	16.6
18–24	6	4.9%	2	33.3	6	6%	2	33.3
24–36	4	3%	1	25	4	4%	1	25
36–48	0	0	0	0	0	0	0	0
48–72	1	.8%	0	0	1	1%	0	0
72+	1	.8%	1	100	1	1%	1	100
	121		26	21	87		22	25

sion that infection is not the most important factor in influencing mortality in war wounds treated with modern methods of chemotherapy. Patients operated upon between four and twelve hours after being wounded comprise sixty-five per cent of the total. There are several reasons for this time lag, among them being difficulty of transportation under blackout and in bad weather, rushes of casualites with the development of a backlog, the difficulty of of keeping up with the swiftly advancing armored units and other tactical reasons.

TABLE II
MISSILES

Type	No. of Cases	Per Cent
Shell fragment	90	69.2
Bullet	38	29.2
Knife	2	1.5

Missiles. (Table II.) The missile was a shell fragment in ninety cases or 69.2 per cent of the 130 cases in which it was known. These fragments came from artillery shells, aerial bombs, mortars and hand grenades. Thirty-eight patients, or 29.2 per cent were struck by bullets from rifle, machine gun or pistol. Knife wounds occurred in two cases or 1.5 per cent. These were long trench knives and were driven in very deeply.

Cases in Which No Visceral Lesions Occurred. There were sixteen cases in which exploratory laparotomy was performed and no visceral lesion found with one death, a mortality rate of 6.2 per cent. These operations were done in cases in which the presence of a visceral injury could not be ruled out. In some the peritoneum had been penetrated or perforated without injury to a viscus.

In several the missile had entered through the chest and appeared to be in the peritoneal cavity. In two cases the missile was found to be in the muscle of the diaphragm, not having gone through it. Others were found to have retroperitoneal hematomas which can cause marked abdominal signs. Some of these were so extensive as to threaten the blood supply of the large bowel so that a colostomy was done. The one patient who died had a peritoneal hematoma, quite extensive, and was operated upon at a time when the enemy had us cut off to the rear so that we could not obtain blood in adequate amounts and it was believed that lack of blood contributed materially to his death.

Many parietal abdominal wounds were explored and if it could be definitely

determined that the peritoneum had not been penetrated, a laparotomy was not done. Such cases are not included in this report.

TABLE III
THE INFLUENCE OF THE SEVERITY OF INJURY UPON THE MORTALITY RATE

Nature of Injury	No. of Cases	Deaths	Mortality Rate Per Cent
Thoraco-abdominal wounds	18	8	44.4
Stomach and other viscera	8	4	50
Small intestine alone	25	3	12
Small intestine and other viscera	35	11	31
Colon alone	10	1	10
Colon and other viscera	34	10	29
Liver alone	8	0	0
Liver and other viscera	16	6	37.5
Kidney alone	1	0	0
Kidney and other viscera	12	5	41.6
Bladder alone	4	0	0
Bladder with other viscera	6	1	16.6
Abdominal wounds with associated compound fractures	40	12	30
Abdominal wounds with associated compound fractures of the femur	5	3	60

Multiple Injuries. There were sixty-five abdominal wounds with associated multiple injuries, an incidence of forty-nine per cent. In this group there were fifteen deaths or a mortality rate of twenty-three per cent. This is about the same as the rate for the entire series. Those with associated multiple soft tissue injuries even had a lower mortality, there being twenty-five such cases with three deaths, a mortality of twelve per cent. Associated compound fractures, however, increased the risk, especially fractures of the femur which gave a grave prognosis. Thus, there were forty cases with associated fractures with twelve deaths, a mortality of 30 per cent, and five cases with associated fractures of the femur with three deaths, a mortality rate of 60 per cent.

Multiple injuries of viscera decreased the individual's chance for survival. By the same token, severity of injury, which is hard to represent statistically, is the most important factor of all in producing mortality. (Table III.)

Thoraco-abdominal Wounds. This is a severe injury, involving as it does both the pleural and peritoneal cavities and the viscera contained in them as well as a laceration of the diaphragm. Some of the abdominal cases had also an associated chest wound with no involvement of the diaphragm, but these are not considered true thoraco-abdominal wounds and are included among the abdominal wounds with associated multiple injuries.

There were eighteen thoraco-abdominal wounds with eight deaths, a mortality rate of 44.4 per cent. Ten were left-sided with five deaths, a rate of 50 per cent, and eight were on the right side with three deaths, a mortality of 37 per cent. The ones on the left side are usually the most serious, often necessitating a splenectomy and frequently involving the stomach and splenic flexure of the colon which are in close proximity to the diaphragm.

The type of operative approach in these wounds varied with the size of the wounds, the direction and path of the missile, and the side on which the wound occurred. The thoracic approach is almost mandatory on the right side, for it is difficult to repair the diaphragm on that side from below because the liver is in the way. However, it is necessary to make an additional abdominal incision if an exploration of the peritoneal cavity is required. On the left side the entire procedure can often be done through the thoracotomy incision. This is the easiest method of doing a splenectomy and a quite extensive exploration of the peritoneal cavity can be done through the left diaphragm. Colostomy for large bowel injuries can be done through a stab wound.

An advantage of a thoracic incision also is that injuries of the thoracic viscera can be visualized and repaired if necessary. If an abdominal approach was employed, the subcostal incision was frequently found

TABLE IV
ANALYSIS OF DEATHS

Cause of Death	Cases	Remarks
Shock	13	All these patients were suffering from shock before and during the operation. Some died within a few hours after the operation and one died on the table while the peritoneum was being closed. Three died at a time when blood was unavailable in adequate amounts and it was believed that this was a major factor
Shock and sepsis	3	These patients all had marked peritonitis at time of operation: two had bile peritonitis and one had extensive fecal peritoneal soiling. Two had been wounded 24 hr. or more before operation
Pulmonary complications	4	Two died from pneumonia and atelectasis. One had severe asthma and ischemic necrosis of one-half of one kidney from lacer. of a branch of a renal artery. One had a chest wound and bilateral pneumonia with fibrinous pleurisy on one side
Embolism	4	These were sudden deaths. One died 11 days post-op. after developing hemiplegia. One, 4 days post-op., pulmonary embolism. One died on the operating table from air embolism accidentally injected during a blood transfusion One presumable fat embolism from an associated extensive fracture of the femur and pelvis
Infection	1	Extensive phlegmon of pararectal region
Intestinal obstruction	1	Multiple angulations of the small intestine which had 17 perforations
Mesenteric thrombosis	1	Ten days postop. after resection of 36 inches of small gut and two colostomies. Very gross fecal soiling at time of operation. No peritonitis at autopsy
Respiratory or cardiac reflex (?)	1	A transthoracic splenectomy in excellent condition at end of oper. Died suddenly when turned on back at end of operation
Total	28	

useful; and in one case the thoracic incision was extended to make a combined thoracoabdominal incision.

Wounds of the Stomach. There were nine cases in which the stomach was injured with five deaths, a mortality of 55 per cent. In only one case was the stomach alone injured and the patient died. The missile in this case was a small flat fragment, 1 cm. in length, which had perforated his winter clothing, the anterior abdominal wall, the anterior stomach wall, and was found imbedded in the mucous membrane of the posterior stomach wall. This was comparatively a trival abdominal wound but the patient died within twenty-four hours of a massive bilateral pneumonia and atelectasis. Upon reviewing the preoperative chest *x*-rays, it was believed he had a diffuse virus pneumonia before operation.

Duodenum. There were two cases with duodenal wounds, both complete transections of the second portion, with very grave associated injuries. A three-layer closure was done in each case but both patients died. One had, beside multiple small intestinal injuries, fractures of four vertebrae with transection of the spinal cord, and the other had lacerations of the lung, liver, left kidney and right ureter.

Small Intestine. Injuries of the small intestine were almost always accompanied by massive intraperitoneal hemorrhage, which had ceased by the time operation was done. A very characteristic feature of this injury is the marked pouting and eversion of the mucous membrane which tends to close the opening or make it smaller, thus diminishing the amount of intestinal contents spilled into the peritoneal cavity. Realizing that resection carries a higher mortality than suture alone, it was only done when the lacerations were so extensive, ragged and confluent that repair was impossible, or the mesentery was injured and stripped away so that the blood supply of the gut was lost.

There was a total of sixty cases in which the small intestine was injured with four-

teen deaths, a mortality rate of twenty-three per cent. Of these the small intestine alone was injured in twenty-five cases with three deaths, a rate of 12 per cent. There were thirty-five cases of small gut injury with associated injury to other viscera with eleven deaths, a rate of 31 per cent.

There were eleven cases in which resection and anastomosis was done with four deaths, a rate of 36.3 per cent. The average number of lacerations of the small gut was 4.8, ranging from a single one to seventeen, the highest number counted.

Wounds of the Large Intestine. Lacerations of the colon were treated by exteriorization, except in a few cases with small lesions which were sutured. Nearly all the colostomies were of the Mikulicz type at first, but later loop colostomies were done entirely, due to reports from General Hospitals, where the closures were being done, that difficulties were being encountered in the ones with spurs. Wounds of the pelvic colon which could not be brought out were repaired, and a proximal colostomy done.

Wounds of the infraperitoneal portion of the rectum were treated by coccygectomy and drainage. Injuries of the colon occurred in forty-four cases with eleven deaths, a mortality rate of 25 per cent There were ten cases in which the colon alone was injured with one death, or 10 per cent. The colon injury was associated with injuries to other viscera in thirty-four cases with ten deaths, a rate of 29 per cent. There were three cases with injury to the rectum below the peritoneum with one death.

Kidney Injuries. There was one patient with injury to the kidney alone and he survived. In twelve cases there was injury to the kidney plus other associated visceral injuries. Five of these died or 41. 6 per cent. Two nephrectomies were done with one death.

Urinary Bladder. There were ten cases with injury to the bladder with one death, a rate of 10 per cent. Four cases had no other visceral injuries, and none of these died, the death occurring among the six with other visceral injuries.

Liver. There were twenty-four cases with lacerations of the liver with six deaths, a mortality rate of 25 per cent. Eight cases were injuries of the liver alone and none of these died, while the six deaths in the sixteen with other visceral lesions gives a mortality rate in this group of 37.5 per cent.

Spleen. There were six cases with injury to the spleen severe enough to require splenectomy. Three of these patients died, giving an operative mortality in this series of 50 per cent.

Pancreas. No pancreatic injuries severe enough to be recorded were seen in this series. Several were seen at autopsy in patients who died without operation. These lesions are usually associated with other grave injuries, so that few of them ever reach the operating table or even the hospital.

SUMMARY

A report of 131 war wounds of the abdomen, operated upon in Field and Evacuation Hospitals in the European Theater of Operations, is presented. The data compiled from this group of cases indicate that the mortality from abdominal wounds in World War II is not greatly influenced by the time lag between injury and operation as has been the case in the past. This is probably largely due to the control of infection by present methods of chemotherapy. The severity of injury, as represented by the extent and multiplicity of visceral lesions, is the major factor influencing mortality in this series. The mortality rates are similar to others reported in the recent war and indicate a marked reduction as compared with the mortality rates of previous conflicts.

The writer wishes to express his thanks and appreciation for their devotion, loyalty and hard work to the following who were members of his surgical team, some for varying lengths of time: Capt. D. W. Ovitt, Capt. Donald Ross, 1st. Lt. Ada F. Bennett, ANC., Capt. Stanley Yudicky, Capt. Samuel Cohen, Capt. C. R. Schroder, T/4 David Coltman and T/4 Melvin Coulter.

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THE FOOT PROBLEM AS SEEN IN SOLDIERS*

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THE soldier's foot is of very important military consideration since a soldier with a painful foot cannot march and is therefore of little value. The causes of painful feet in soldiers are innumerable and it is not possible to discuss them all thoroughly. The various foot conditions will be enumerated and only the more common ones will be described.

In order to treat a painful foot properly, one must be able to recognize and evaluate the clinical findings present. A proper concept of the anatomy and physiology of the foot is a prerequisite to proper diagnosis and therapy. An adequate history must be obtained and examination made to determine the etiological factor present. Systemic causes for painful feet must not be overlooked.

In order to cope with the foot problem in soldiers, prophylactic measures must be employed to prevent disabling symptoms. These consist of adequate shoe and sock requirements as well as general care of the feet.

THE SHOE

Requirements. A well formed correct military shoe should have: (1) a straight last, (2) a narrow heel and broad toe, (3) a shank of moderate width, (4) a non-irritating counter and (5) *soles* made of leather; rubber soles are undesirable.

Fitting. Shoes are fitted by one of two methods: (1) by a machine which measures the foot during weight bearing; (2) by hand; shoes should be ¾ inch longer than the foot during weight bearing and sufficiently wide to avoid crowding the toes.

Care of Shoes. After an accurate shoe fit is obtained, proper care must be given them in order to assure continued comfort: (1) Shoes trees should be used when possible. (2) Shoes should be dried into proper shape when wet. (3) The lining of shoes should be smooth.

"Breaking in" of New Shoes. When properly performed, this will prevent many foot ailments. New shoes can be "broken in" by one of two methods: (1) Waterproof shoes in oil; this is not good for perspiring feet. (2) Stand in water for five minutes and then walk around until the shoes dry on the feet.

Care of Hosiery. Proper care of hosiery is also important to avoid a painful foot. (1) Light weight woolen socks are best. (2) Hose should fit well. Socks should not be short but should be of proper length. (3) Socks should be changed daily.

Care of the Feet in General. In addition to wearing properly fitted shoes and socks, the soldier must give his feet essential prophylactic care in order to prevent painful disabilities: (1) Bathe the feet regularly. (2) Dry them well between the toes. (3) Expose the feet to the sun regularly. (4) Prevent chafing by use of foot powder

FOOT CONDITIONS COMMONLY FOUND IN SOLDIERS

1. *Blisters and Abrasions.* These are due to irritation from socks and lining of shoes. They are treated by opening the blisters aseptically through healthy area and applying a dressing.

11. *Ingrown Toe Nails.* The lateral edge of the nail curls downward and becomes

* Presented to the AAF Twelfth Regional Orthopedic-Fracture Conference at Duke University, Durham, N. C., November 27, 1943. The patients referred to were treated at Station Hospital, Camp Mackall, N. C.

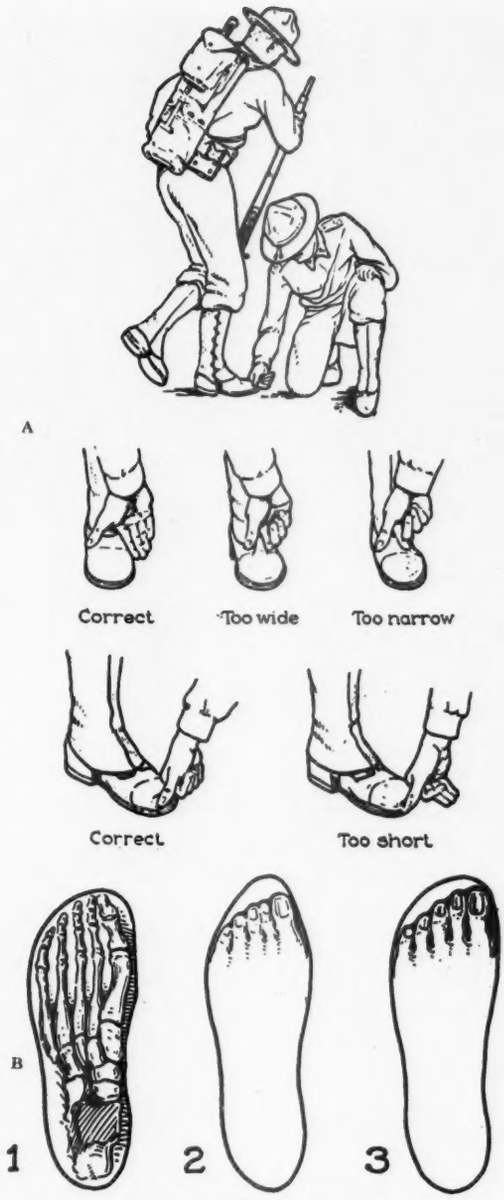

Fig. 1. A, shoe fitting. Shoes should be ¾ inch longer than the weight bearing foot and wide enough to avoid crowding the toes. B, anatomical study of shoe fitting: 1, effect of too short a shoe; 2, effect of pointed toe shoe; 3, a good foot in a well fitted shoe. (From *The Military Medical Manual*, 5th ed., courtesy of The Military Service Publishing Co.)

embedded in the adjacent soft tissue. Inflammation and secondary infection ensue. These are caused by short, narrow shoes, short, tight socks, or improper cutting of nail. In early cases elevate the nail edge by inserting cotton pledget under it. In late, infected cases, excise the lateral nail margin with its matrix

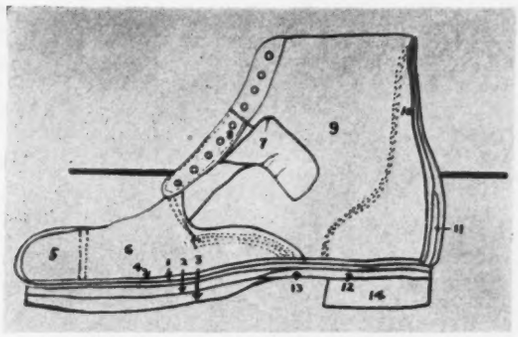

Fig. 2. Construction of a shoe as seen in longitudinal section: 1, welt; 2, slip-sole; 3, outer sole; 4, insole; 5 toe cap; 6 vamp; 7, tongue; 8, eyelet facing; 9, quarter; 10, backstay; 11, counter; 12, heel seat; 13, shank, 14, heel.

and adjacent inflamed soft tissue. Apply vaseline gauze dressing.

III. *Subungual Hemorrhage.* These are due to an injury, usually from a falling object. Treatment involves drilling the nail and releasing the blood.

IV. *Hangnails and Paronychia.* When infection is present incision and drainage is indicated.

V. *Cracks and Fissures.* These are common between the toes due to perspiration, or when the toes are not dried after bathing. Antiseptic powders are useful as a prophylactic. They cake and irritate when applied to the fissure. Powders are Army foot powder and zinc stearate. Dyes such as gentian violet can be used; and if adjacent callous is present, excise it

VI. *Corns and Callouses.* These hypertrophic areas of the horny layer of the skin are very common among soldiers. Hard corns are usually present over the dorsal aspect of the toes and are due to shoe pressure. Treatment involves relief of pressure by properly fitted shoes; the application of a doughnut-shaped felt pad; the shaving off of hyperkeratotic area, or the excision of the corn *in toto.*

Soft corns are usually present on the interdigital surface of the toes and are caused by irritation from a spur or lipping on the adjacent phalanx, as well as by perspiration. Treatment includes the keeping of the interdigital space clean and

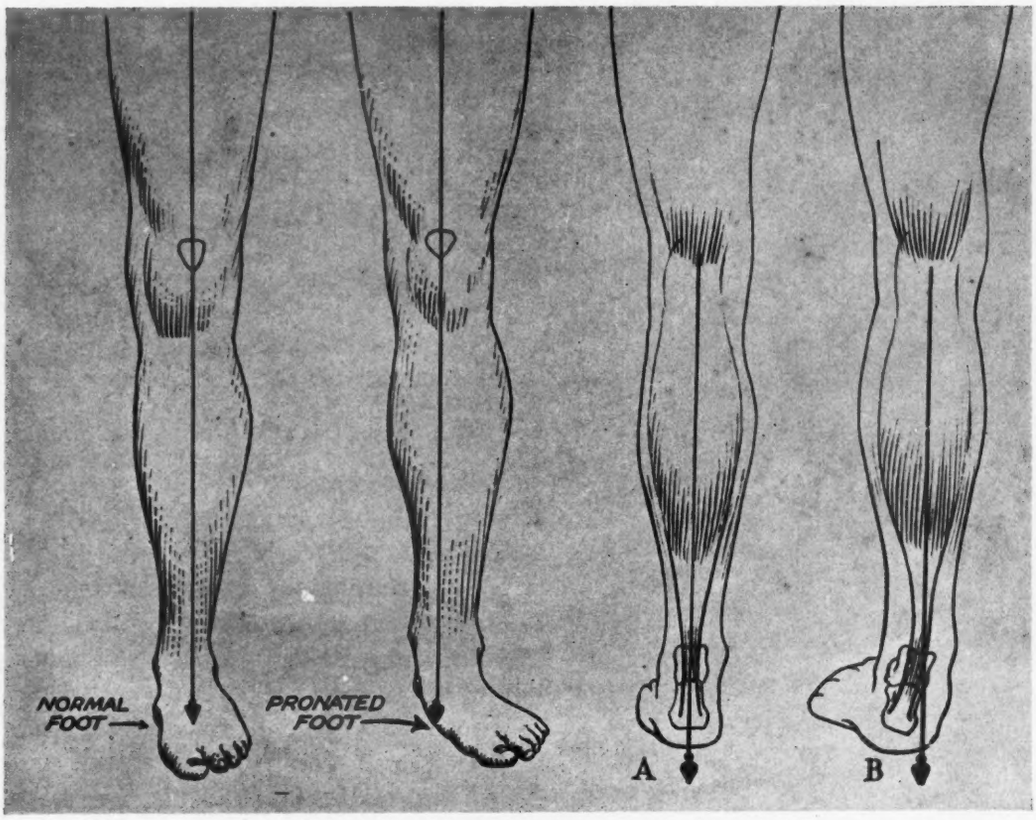

FIG. 3. Relation anteriorly of plumb line dropped from middle of patella to the normal and flat foot; similar relation of plumb line dropped from middle of poplitsal space to normal A and flat-foot B. (LEWIN, Courtesy of *Am. Jr. Dis. Child.*)

dry with alcohol and powder; the application of a felt pad between the toes to prevent pressure over the corn. Excision of bony spur when present should be carried out. If infected, hot boric acid foot soaks should be employed.

VII. *Bromidrosis.* Excessive perspiration may be due to overweight or glandular disturbance. This can be counteracted by local applications of 25 per cent aluminum chloride solution applied for three successive nights at weekly intervals, frequent foot baths, and the application of army dusting powder.

VIII. *Athletes Foot, (Epidermophytosis).* This condition is very common among soldiers. It is due to a fungus infection and is manifested by itching, vesicle formation, and maceration of the skin between the toes. The nails become ridged and keratotic. Scrapings from the lesion are placed in 20 to 30 per cent potassium hydroxide and examined microscopically for spore or chain-like organisms. Prophylaxis includes: (1) Avoid walking barefooted; wear wooden shoes in shower; (2) employ foot bath of 10 to 15 per cent cadium sodium thiosulfate before entering shower; (3) avoid woolen socks and change socks daily.

Treatment involves: (1) Keeping the feet clean and dry; (2) local applications of Whitfield's ointment; dyes such as gentian violet; dusting powders; (3) ultra violet ray or sunlight exposure of feet; (4) avoiding spread of infection to other parts of the body; and (5) boiling socks and changing them daily.

IX. *Static Disability of the Foot.* The bulk of soldiers seen with painful feet fall into this category. Static foot deformities consist of flat feet, metatarsalgia, and March fracture.

FLAT FEET

The etiology may be hereditary, associated with fusion of the tarsal bones or presence of an accessory scaphoid, trau-

FIG. 4. A. T., twenty-one years of age, march fracture, second left metatarsal, mid-shaft. Onset of pain after prolonged drill session end of May, 1943; foot strapped without relief; hospitalized June 16, 1943. A, June 7, 1943, incomplete oblique fracture line, second left metatarsal, mid-shaft; B, June 14, 1943, mild periosteal proliferation; C, June 21, 1943, marked increase of periosteal proliferation; irregular shaggy outline of callus; D, June 28, 1943, more regular outline of callus; E, July 5, 1943, ossification of callus; trabeculation present. Treated with bed rest; returned to duty July 6, 1943, with shoe correction.

matic or postural, with or without associated obesity and glandular disturbance. Regardless of the underlying cause, however, the problem confronting us is to differentiate the symptomatic from the painless flat foot. In a large percentage of cases, the complaints of the patient are unreliable. It is common knowledge that the height and shape of the longitudinal arch do not completely determine the strength or usefulness of the foot. Yet a large number of soldiers have come to realize that a plano-valgus position of the foot is a possible invitation to a C.D.D. We must recognize and evaluate the objective findings in order to dispose properly of a case of pes planus. Is there pronation of the foot with inward rotation of the astragalus and os calcis, resulting in lateral inclination of the achilles tendon? Is there peroneal spasm or actual contracture with restricted mobility of the foot? Are callouses present to indicate abnormal weight bearing? If so, the patient's complaints of pain, fatigue, and tenderness under the calcaneo-scaphoid or spring ligament may be justified.

Mild or moderate cases are treated with shoe corrections, arch supports and corrective exercises as follows:

Shoe Corrections. A Thomas heel can be used (inner border lengthened to scaphoid tubercle and elevated one-eighth to one-quarter inch). Longitudinal cookies or scaphoid pads can be inserted. Either the rigid or flexible arch supports may be used. Exercises are all important in order to strengthen the muscles which help

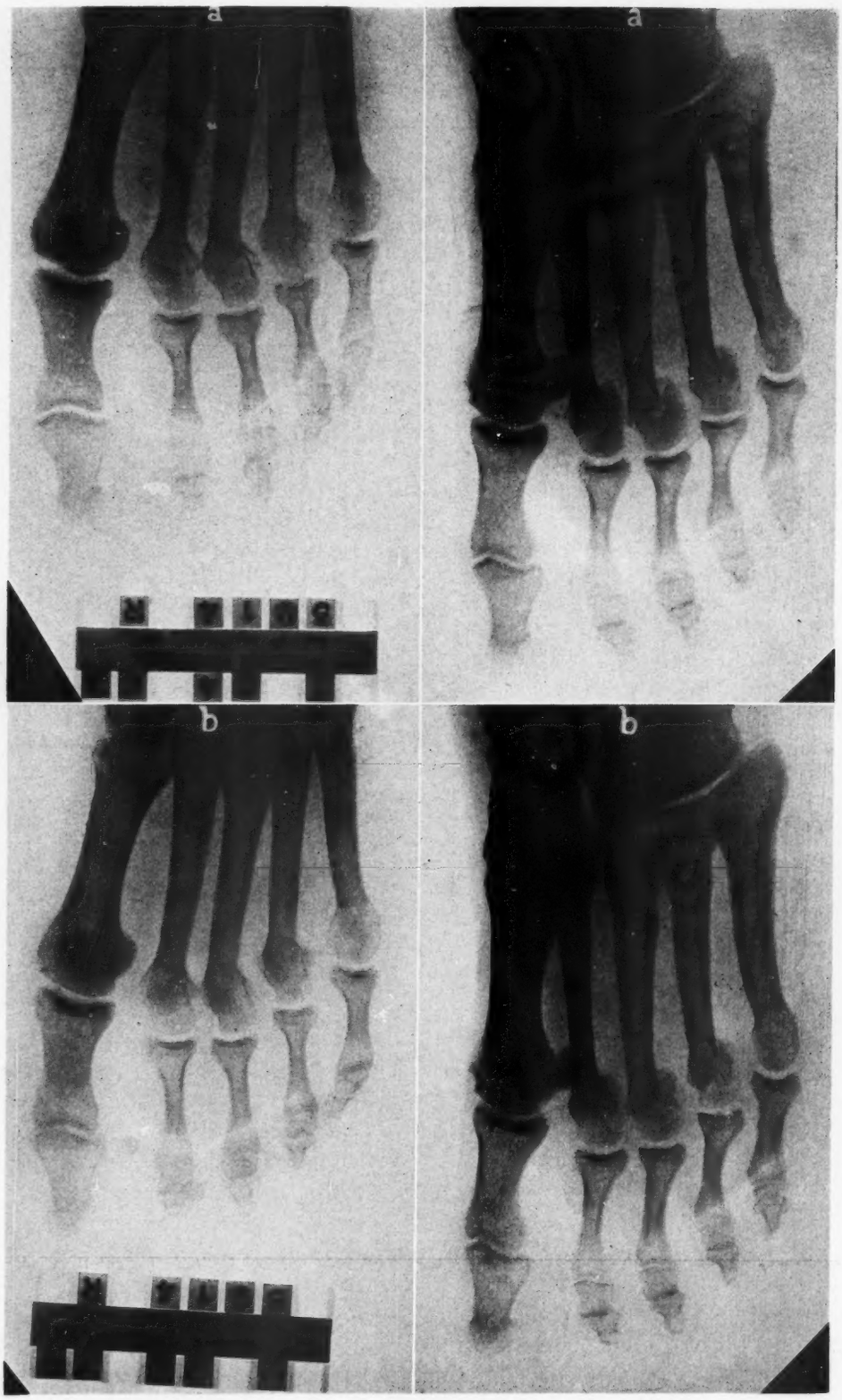

FIG. 5. D. M., nineteen years of age, parachute jump fracture, neck of second, third and fourth metatarsals, right, accidentally incurred July 23, 1943. A, July 24, 1943, note fractures at neck of second, third and fourth metatarsals; B, August 30, 1943, practically no external callus noted; union clinically; treated by immediate hospitalization and plaster of Paris cast for five weeks; returned to duty with shoe correction.

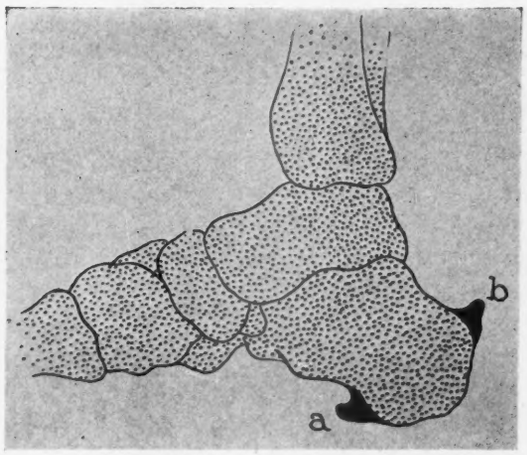

Fig. 6. Exostosis of os calcis with (*a*) ordinary calcaneal spur and (*b*) exostosis at postero-superior angle. (Lewin "The Foot and Ankle," Courtesy of Lea and Febiger.)

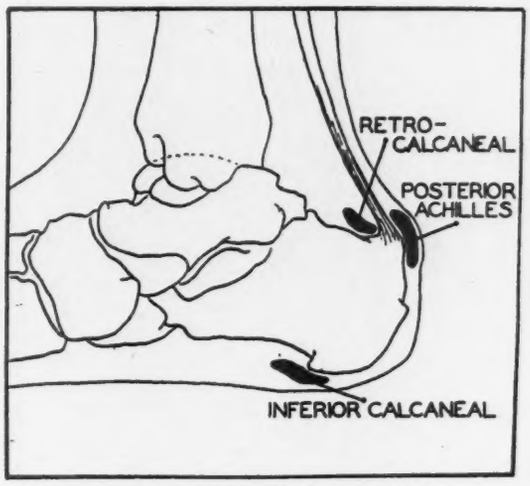

Fig. 7. Bursae of the heel. Note the inferior calcaneal spur. (Shands. "Handbook of Orthopedic Surgery," courtesy of C. V. Mosby Co.)

elevate the arch. They require only a few minutes and some of them can be performed even with the shoes on. They do give a measure of relief. These are: (1) Standing position; elevate the arch by inverting the hindfoot while the forefoot is maintained flat on the floor. (2) Sitting position with legs crossed; actively invert and dorsiflex the suspended foot. (3) Sitting position; pick up marbles with the toes; then invert and dorsiflex the foot and carry the marble to the front of the opposite foot. (4) Walk on supination board. (5) Stretch short achilles tendon. Standing, with one foot advanced in the thrust position. Completely extend the hind knee with the foot flat on the floor.

Attempt is made to return these mild cases to regular duty after the above rehabilitation has been carried out. Frequently, this is not possible, whereupon these patients are placed on duty without field service. Many of these mild cases persist in their complaints and even develop other complaints without organic basis. The psychiatrist labels these cases psychoneurotic and the patients accomplish their aim by receiving an honorable discharge.

Severe cases with peroneal spasm and rigidity of the foot, or cases with marked eversion with inward rotation of the astragalus and os calcis are recommended for C.D.D. in accordance with Circular #164 and MR 1-9. Surgical procedures such as section of the peroneal tendons; the Miller operation with fusion of the joints between the scaphoid, internal cuneiform and base of the first metatarsal bones; the Hoke operation with fusion of the scaphoid, internal and middle cuneiform bones; and the Zadek operation with subastragalar wedge resection and arthrodesis are not carried out in the Army.

METATARSAL ARCH DEFECTS

Static depression of the metatarsal arch is usually associated with pes planus. The abnormal weight bearing results in callous formation, pressure on the interdigital nerves and bursitis. Injury may result in a similar defect. When heredity is the etiological factor, pes cavus or Morton's syndrome may also be present.

The patient complains of pain on prolonged weight bearing. The obvious depression of the metatarsal arch, the tendency to claw-toe, and the callous formation under the metatarsal heads confirm the symptoms. The findings are more marked in the cavus foot.

Treatment at our hospital consists of the shoe corrections, supports and exercises

FIG. 8. M. P., twenty years of age, Freiberg's infraction, third left metatarsal. Note broadening, irregularity and flattening of metatarsal head. Two small osteochondral bodies are present within the metatarsophalangeal joint. Injury in 1939; disposition; duty without field service; shoe correction.

outlined for pes planus, with the addition of transverse bars applied to the shoes. In cases in which fixed hammer toe is present, tenotomy of the flexor and extensor tendons with plantar capsulotomy at the interphalangeal joint will correct the deformity. Surgery of hammer toes, however, is not recommended in the Army. The possibility that short shoes may be an etiological factor should be investigated and corrected if necessary.

MARCH FRACTURE

This condition is very prevalent at our Camp where twenty-five mile hikes and double-timing are popular outdoor sports. The history is quite typical. During or following a long march, the patient experiences pain in the forefoot. Rest overnight gives him some relief, and he attempts to continue on duty. Persistent and accentuated pain, however, brings him to the dispensary. *X*-rays are taken, found to be negative, and the foot is therefore strapped to relieve a supposed sprain. The symptoms continue with further weight bearing, and some time later check-up *x*-rays reveal a fracture line or proliferative periostitis. Clinically, local enlargement and tenderness are noted, and the patient is hospitalized.

Serial *x*-rays have unfolded an interesting, progressive, gross pathological process. The original roentgenograms are either negative, reveal an infraction, or a complete fracture even with some displacement. In one case the fracture was comminuted. The fracture line may be present at any level of the metatarsal bone from the base to the neck. In the majority of instances, however, the mid shaft is involved. The third right metatarsal was

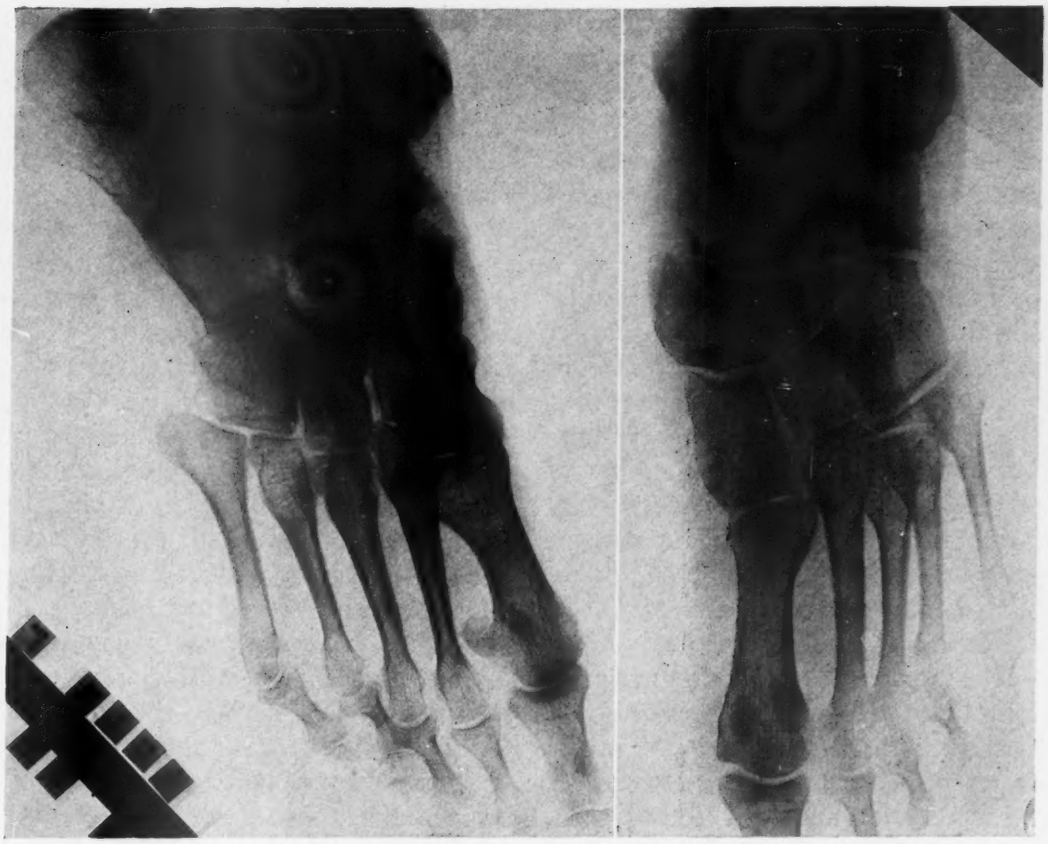

Fig. 9. L. T., twenty-five years of age, pes planus 3°, bilateral; hypertrophic arthritis, astragaloscaphoid joint, bilateral, with deformity of head of astragalus and body of scaphoid. Disposition; C.D.D.

most commonly involved; the right and left second metatarsals were equally involved and almost as frequently as the third right. Generally the fracture line was indistinct at first, with little or no periosteal proliferation. Subsequent films revealed increase of periosteal callus with shaggy, irregular outline. Bone resorption at the fracture site was also noted in the later films, causing the fracture line to become wider and more distinct. Final *x*-rays revealed complete ossification of the newly formed callus with regular and distinct outline. The fracture line again became narrowed or completely obliterated. The degree of fracture, the amount of resorption at the fracture site, and the amount of callus subsequently formed are dependent upon how soon the patient is taken off active duty status following the appearance of symptoms and confined to bed. When weight bearing is continued for days after the onset of symptoms, one can expect marked *x*-ray changes, even if the original roentgenograms are negative. When confinement to bed is carried out immediately after the symptoms appear, the *x*-ray changes are minimal.

Treatment. The proper management of March fracture requires its early recognition. Unprotected weight bearing should be discontinued as soon as the symptoms appear. Do not wait for positive *x*-ray findings. Clinical evidence should be sufficient to make a presumptive diagnosis of probable March fracture. A history of a long march with resultant pain and tenderness over one or more metatarsal bones, with local soft tissue swelling, and with or without palpable local bony enlargement is enough evidence to warrant confining the patient to bed. Subsequent roentgenograms will reveal the fracture

line and periosteal proliferation. The earlier the patient discontinues weight bearing, the less tendency will there be for excessive callus to form; the less tendency will there be for bone resorption to occur at the fracture site; and the earlier will complete ossification of the callus take place. The entire cycle of the entity will therefore be shortened and the patient will be able to return to his duties at an earlier date. The ideal method of treatment therefore is to confine the patient to bed with or without plaster of Paris immobilization for about three weeks. Avoidance of weight bearing is the important factor. In cases of multiple fracture of the metatarsal bones, the foot should be immobilized in a plaster of Paris cast to prevent deformity. The patient should not be permitted to resume weight bearing until the *x*-rays reveal subsidence of periosteal proliferation and complete ossification of the callus present. This is evident when the shaggy, irregular appearance of the early callus takes on a regular, smooth and distinct outline with trabeculation characteristic of ossification. Weight bearing may then be permitted with shoe correction. Transverse bars are fixed to the shoes, and in some cases, Thomas heels and longitudinal cookies are also applied. All of our patients have returned to regular duty. The length of temporary disability varies directly with the elapsed time between the onset of symptoms and the institution of treatment.

x. *Pes Cavus.* I have been rather surprised at the relatively large number of cases of pes cavus seen at our hospital. As a result of the metatarsus equinus with complete obliteration of the metatarsal arch, sustained weight bearing is very uncomfortable. Callosities develop under the metatarsal heads as well as over the dorsal aspect of the toes, which assume hammer position. The majority of cases seen were idiopathic in etiology. One case was due to poliomyelitis and one presented a mild spastic element. Since all of the cases were LOD, no, EPTI, they were recommended for duty without field service or C.D.D., depending upon the severity of the condition. Those who remained in service received corrective shoes. The majority were separated from the army.

xi. *Fracture of Metatarsals Due to Parachute Jump.* These fractures differ from March fracture in that the site is generally through the distal third of the metatarsal bone at the neck. Usually there are more than one bone involved. In the majority of cases seen at our hospital, the neck of the second, third or fourth metatarsals were fractured. We have had isolated fractures of the fifth metatarsal neck. These fractures roentgenologically resemble the early stage of March fractures which occur in the neck of the metatarsal bone. In the cases of parachute jump, however, one does not see the deposition of excessive callus nor the local bone resorption at the fracture site. This is true even in the cases with displacement of the heads of the metatarsals, where the trauma must have been considerable. In these parachute jump cases, the fracture line remains thin, and bony union occurs with minimal callus formation. This is due to the fact that these patients are hospitalized immediately after their injury and confined to bed. With the discontinuance of weight bearing, subsequent repeated trauma and strain, which are the stimuli for excessive callus formation are avoided.

Painful Heels. These are usually due to spurs or bursitis. This condition has not been commonly met with at our army camp. Spurs are usually located on the inferior medial aspect of the os calcis, at the attachment of the plantar fascia, or on the posterior superior surface. Treatment may be non-operative, when corrective shoes are used to relieve pressure. Operative treatment consists of excision of the spur.

Bursitis is located: (1) Retro-achilleal; adventitious; superficial to achilles tendon; (2) retro-calcaneal; calcaneal; deep

to achilles tendon, and (3) subcalcaneal; overlies spur. Treatment consists of shoe correction, novocaine injection, or excision of bursa.

XII. *Affection of Toes. Hallux Valgus:* The etiology is usually shoe pressure. Properly fitted shoes are essential for relief. If joint changes are present with evidence of hallux rigidus, relief can be obtained by means of a steel insert into the sole extending from the heel to the toe, parallel with the big toe, to prevent motion at the metatarsophalangeal joint. Operative correction has not been carried out at our station.

Overriding 5th Toe: This is not uncommonly seen. Pain is due to shoe pressure. Either shoe correction is essential to relieve pressure, or operative correction must be performed. Freiberg's operation or amputation of the toe may be indicated.

Tenosynovitis: Tenosynovitis involving the achilles, extensor hallucis longus and extensor digitorum longus tendons and sheaths is not uncommon. The treatment is rest and relief from pressure.

There are many other foot conditions which I have seen at our hospital, which will only be briefly mentioned.

One case of thromboangeitis obliterans was picked up in an officer who complained of pain in the knee. He was transferred to a General Hospital where the diagnosis was confirmed.

A neurofibroma was excised from the plantar aspect of a foot and the soldier returned to active duty.

Several cases of poliomyelitis have been observed and were recommended for C.D.D. One soldier gave a history of poliomyelitis, yet no clinical evidence of it was found. He developed a marked limp with inversion of the left foot after two months in service. He was ordered to walk normally, and he did, right back to duty.

Another soldier gave a history of poliomyelitis at the age of three years, as well as a history of having been born with a deformed foot. He wore a brace from the ages of two to nine years and recovered sufficiently to become a truck driver before his induction. He presented a mild metatarsus adductus and obvious voluntary clawing of the toes. His limp was exaggerated, and he required coaxing to move the foot actively through its free range of motion. Muscle power appeared normal and the reflexes were active. The metatarsus adductus was easily correctible. *X*-rays revealed obliquity of the distal surface of the cuboid and internal cuneiform bones as the cause of the congenital deformity. The shoe was corrected with a raise on the outer border of the sole and a transverse bar was applied. The patient was able to return to duty without field service.

One case presented an abscess of the left foot with low grade osteomyelitis of the internal cuneiform. Incision and drainage was performed with healing, and the patient was returned to duty without field service.

A young soldier had landed on a nail with his left heel about nine years ago. He developed an infection which was drained by incision many times. *X*-ray revealed irregularity of the posterior aspect of the os calcis. Because of pain and the history of spontaneous drainage every three to four months, a C.D.D. was recommended.

A twenty year old private tripped and injured his left foot as a civilian. He limped with pain ever since. He presented a mild dorsal prominence over the head of the third left metatarsal with mild tenderness. Motion at the metatarsophalangeal joint was free. The roentgenogram revealed broadening, irregularity and flattening of the third metatarsal head with two small osteochondral bodies in the joint. This resembled a Freiberg's infraction. A transverse bar was applied to the shoe and the patient placed on duty without field service.

A nineteen year old private presented an absence of the third and fourth toes of the left foot due to an old gunshot wound.

Symptomatic depression of the metatarsal arch was present. He was given a transverse bar and placed on duty without field service.

A thirty-two year old soldier presented bilateral, severe hallux valgus with bilateral, severe, second hammer toe. Because of his symptoms, a C.D.D. was recommended.

One twenty-five year old soldier revealed severe bilateral pes planus with bilateral hypertrophic osteo-arthritis of the astragalo-scaphoid joints. He gave a history of painful feet since childhood. C.D.D. was approved.

COMMENT

From the above, it is evident that there are many foot conditions which can disable a soldier. Many of these are of a minor and temporary nature, but nevertheless as disabling as a serious condition. Prophylactic measures can avoid some of these temporary disabilities. When they occur, however, immediate and effective treatment is necessary to restore the soldier to active duty status as rapidly as possible. Each case of foot disability will require individual final judgment and disposition in order to comply with W.D. Circular No. 164, pertaining to the use of manpower based on physical capacity. Each enlisted man should be assigned to a position in which he can render the maximum service. The discharge of men who can render effective service is prohibited. On the other hand, the retention of men unable to perform a reasonable day's work for the Army is wasteful.

Acknowledgment is made of some of the illustrations, which were taken from the books of Lt. Col. Philip Lewin and Lt. Col. Alfred R. Shands. The roentgenograms are of cases treated at our hospital.

SURGICAL ASPECTS OF CARCINOMA OF THE STOMACH*

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THIRTY-FIVE cases of carcinoma of the stomach on General Surgical Service "B" from 1929 to 1934 and 114 cases of carcinoma of the stomach on General Surgical Service "A" from 1934 to 1944 are included in this survey. These cases constitute the total number of patients with gastric carcinoma seen by these services during the stated years at the Hospital of the University of Pennsylvania, Philadelphia. There were

TABLE I
SEX INCIDENCE

Sex	No.	Per Cent
Male	95	64
Female	54	36

ninety-five cases or 64 per cent in males showing the greater incidence in this sex with almost a 2 to 1 ratio. The age incidence showed 81 per cent of the cases between the ages of forty and seventy with the greatest number (34 per cent) between fifty and sixty years of age.

TABLE II
AGE INCIDENCE

Years	No.	Per Cent
20–30	1	0.5
30–40	9	6
40–50	33	22
50–60	51	34
60–70	37	25
70–80	17	12
No age	1	0.5

It was interesting to note the lag between the time the patient first saw a physician and the time the patient reached the surgeon. Unfortunately, the records did not always contain the data as to when the patient reached the local physician but as a rule this was within a month after the onset of symptoms. Seventy-five per cent of the cases reached the surgeon three months or longer after the onset of symptoms with 42 per cent reaching the

TABLE III
DURATION OF SYMPTOMS BEFORE CONSULTING M.D.

Time	No.
No record	101
1 week	14
1 month	21
2 months	4
3 months	5
6 months	2
1 year	2
Over 1 year	0

surgeon one year or more after the onset of symptoms. This certainly leaves much to be desired. One hundred thirty-five cases or 91 per cent were able to be explored while 9 per cent were considered inoperable without exploration. Of the group

TABLE IV
DURATION OF SYMPTOMS BEFORE REACHING SURGEON

Time	No.	Per Cent
No record	4	3
1 week	1	0.5
1 month	5	3
2 months	29	19.5
3 months	22	15
6 months	25	17
1 year	33	22
Over 1 year	30	20

explored only fifty-two patients or 35 per cent were operable. This implies that the surgeon felt he could remove all the lesion and the gastrocolic or gastrohepatic nodes which appeared involved. Of the number resected in this series, fifty-one patients or 34 per cent had a subtotal gastric

* This series is taken from the services of Dr. G. P. Muller and Dr. E. L. Eliason.

resection with gastrojejunostomy. Only one case had a total gastric resection.

In the inoperable cases which were explored, simple gastrojejunostomy was done in twenty-six cases as a palliative procedure and gastrostomy was done in two cases. Fifty-five of the cases explored were so far advanced that no procedure was attempted.

TABLE V

Cases able to be explored

135 = 91% — Operable —52 = 35%
Inoperable—83 = 56%

Cases not able to be explored

14 = 9%

56 + 9 = 65% inoperable

In the overall group, 43 per cent experienced relief of symptoms while 55 per cent did not. The total five-year cures were three or 2 per cent of the total 149 cases in this series. There was no follow-up record in forty-one cases while twenty-six died while still in the hospital following operation. Of these postoperative deaths, twelve of the twenty-six had gastric resection while fourteen had simple exploration or gastro-enterostomy. Thirty-nine of the patients lived six months, twenty-six lived one year, thirteen lived two years, and one lived four years. Of the three five-year cures, one is still living after eight years, one is living after fourteen years and one died after eight years due to the carcinoma. The three five-year cures all had a subtotal gastric resection. The one patient in which total gastric resection was done died postoperatively of pulmonary embolus.

TABLE VI

Procedure Done in Operable Cases:

Subtotal resection—51	= 98%	= 34%
Total resection — 1	= 2%	= 1%
		35%

TABLE VII

Procedure Done in Inoperable Cases Which Were Explored:

Gastroenterostomy—26	= 17%	
Nothing —55	= 37%	
Gastrostomy — 2	= 2%	
		56%

These results are not encouraging. One thing is made clear, however; the patient reached the surgeon entirely too late. Until we know the etiology of carcinoma of the stomach, the only way we can improve our results is to see that the patients get to the surgeon earlier or that our present form of therapeutic attack is improved. The latter point will be discussed shortly. As can be seen from this series, only 35 per cent of the cases were operable and many of these already had visible spread to the adjacent gastrocolic and gastrohepatic nodes. The cases in which the pathological condition was actually limited to the local lesion as such were nil. Thus before we consider the form of operation offered these patients we realize the surgeon is at a handicap before he starts.

TABLE VIII

Per Cent Relief of Symptoms: Yes—64—43%
No —85—57%

TABLE IX

SURVIVAL PERIOD

Time	No.	Per Cent
No record	41	27
P. O. Death	26	17
6 months	39	26
1 year	26	17
2 years	13	9
3 years	0	0
4 years	1	1
5 years	3	2

P. O. Death 12 subtotal resections
14 expl. or enter.

What is the answer to this problem? Is it routine upper gastrointestinal roentgenology just the same as we advise yearly routine chest films? St. John, Swenson and Harvey,[8] of Columbia University, tried an experiment in the early diagnosis of gastric carcinoma consisting of mass roentgen studies of persons over fifty who had no digestive symptoms of perceptible

significance. Of 2,413 studied, three had unsuspected malignant gastric tumors, an incidence of 1.24 per 1,000. These three underwent subtotal gastric resection. Obviously this study is only in the experimental stage and should be continued for many years to prove its value. It may be one of the answers to the problem.

A more direct answer at present seems to be found in the patients who have gastric symptoms. In the present day of specialization the surgeon can do little actual ground work to aid the cause. The real boost has to come from the general practitioner and gastrointestinal specialists who see these patients first. The time lag between when the patient first sees the doctor and reaches the surgeon is considerable.

Thorstad[4] reports that over a fifteen-year period from 1928 to 1942 there has been no marked annual increase in the admissions for cancer of the stomach at two of Detroit's large hospitals. He also stated that no evidence has been found to indicate a marked improvement in either the diagnosis or treatment of early carcinoma of the stomach during this fifteen-year period. Earlier diagnosis on the part of the general practitioner and the gastrointestinal specialist and prompt surgery is essential if we are to improve our results in the treatment of carcinoma of the stomach.

Some authors have reported better results in the overall five-year cures in their clinics. Custer[7] reports 18.75 per cent alive and well for over eight years. If one breaks this figure down, however, it is seen that the series which he reports contained 463 patients. Of these only 141 were operable and of the 141 operated upon only ninety-six were completely followed. It is this total ninety-six that he considers eighteen cases or 18.75 per cent alive and well for over eight years. In terms of the total number of cases in his series, only 3 per cent are alive and well for over eight years. This is only a slightly better percentage than our overall five-year cure rate of 2 per cent.

As for the second line of attack in improving our results, the question of total gastric resection in borderline operable cases is raised. It is known that man can get along almost as well without any stomach as with one-third or one-fourth of it left as shown by the studies of Ingelfinger.[5] Hence the physiologic aspect of either procedure is justified.

It is just within recent years that the pendulum has swung to the possibility of more widespread use of total gastric resection in borderline operable cases of carcinoma of the stomach.

Lahey and Marshall[1] and Jones and Kehm[2] have reported two series of total gastrectomy and their results are noted here: Lahey and Marshall[1] report seventy-three cases seen since 1938 with twenty-four postoperative deaths but in the last two years only five deaths occurred in twenty-eight cases. As stated, the procedure was only used in borderline operable cases or in which the lesion was high in the cardia of the stomach. In the majority of cases, total gastrectomy with anastomosis of the jejunum to the esophagus through the abdomen was done provided enough normal esophagus remained. They reported one five-year cure out of the seventy-three cases. The procedure carried a very high mortality with only forty-eight of the patients surviving operation; fifteen lived a year or longer before recurrence caused death; twelve survived one year, seven survived two years and one survived four and one-half years.

The report of Jones and Kehm is a later one and harder to evaluate. However, indications for total gastrectomy by these men were the same as by Lahey and Marshall. Of their eight consecutive cases, however, the patients are all living at present, the postoperative period varying from six to eighteen months.

Naturally, the procedure can be used only in selected cases. Its widespread use would only result in an increased operative mortality in patients with lesions too widespread for surgery, but with its greater

use in selected cases, perhaps we can increase our therapeutic results. Certainly it deserves a trial when our overall five-year cure rate with present means of attack is only 2 per cent.

CONCLUSION

The conclusion to be drawn from the statistics here reported is that cases of carcinoma of the stomach reach the surgeon many months after the onset of symptoms when the lesion is far advanced and inoperable, with the result being that the only thing we have to offer these patients at the present time, namely, gastric resection, was applicable in only 35 per cent of the cases. The inadequacy of partial gastric resection is also shown when the end result of 2 per cent five-year cures is considered. The possibility of obtaining better therapeutic results with the more widespread use of total gastric resection in borderline operable cases is discussed.

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INDICATIONS FOR DETERMINATION OF THE THICKNESS FOR SPLIT SKIN GRAFTS*

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IT is now a self-evident truism that many of the advantageous properties of a skin graft with certain exceptions provided a good "take" can be obtained, become maximal the thicker the applied skin graft has been cut on the contrary, as a rule, the disadvantageous properties save that of a certainty of a "take" increase as the skin graft is cut at a more superficial level. This fact suggests the need of attaining in most instances if possible, a skin graft cut at such a level that most of the good qualities of the thin and the thick skin graft will be embraced while the disadvantageous qualities of each will be minimized. A skin graft cut at a uniform thickness also has obvious advantages. Often because of conditions beyond the control of the surgeon both as to the recipient area and donor site, it is an obvious advantage to a large extent to be able to predetermine the thickness of the skin graft. Another aid, sometimes an almost indispensable one, is to be allowed to use a suitable part of the body for a donor site. When a considerable amount of skin has to be taken, a final advantage is

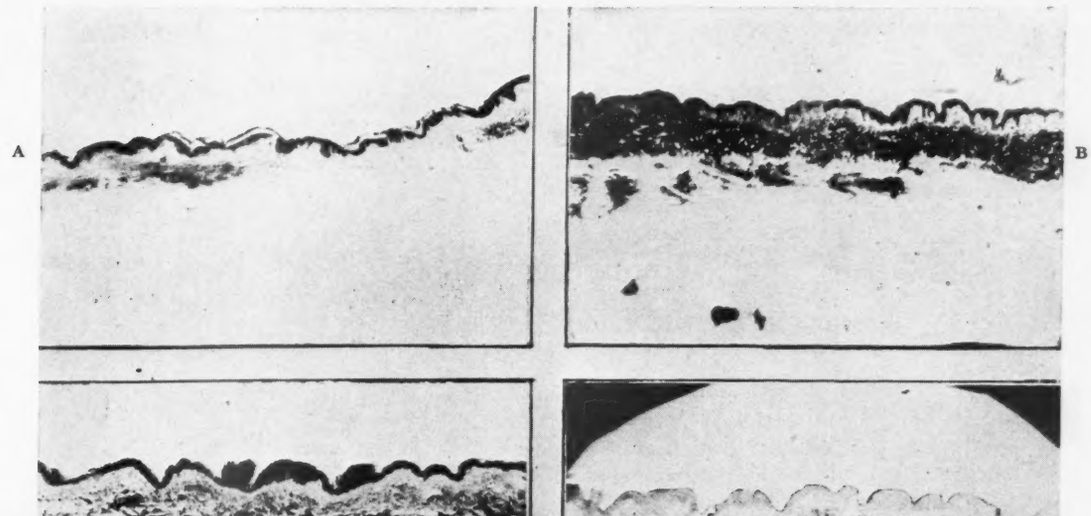


FIG. 1. Sections of thin and moderately thick calibrated skin grafts. X 16. A, male adult graft cut from abdomen about .010 of an inch (.25 mm.) in thickness used to cover a granulating area; a good "take." B, male adult graft cut from abdomen about .012 of an inch (.3 mm.) in thickness used to cover a granulating area; a good "take." C, male adult graft cut from abdomen about .018 to .020 of an inch (.46 to .5 mm.) in thickness. Graft used to cover back of hand on clean raw surface; a perfect "take"; no blistering. D, male adult graft cut from outer thigh used to cover clean raw surface of dorsum and palm of both hands, .014 to .016 of an inch (.36 to .41 mm.) in thickness; a good "take." (From PADGETT. "Skin Grafting." Charles C. Thomas Co.)

* From the Surgical Department, University of Kansas, School of Medicine. Delivered before the American Society of Plastic and Reconstructive Surgery, New Orleans, Louisiana.

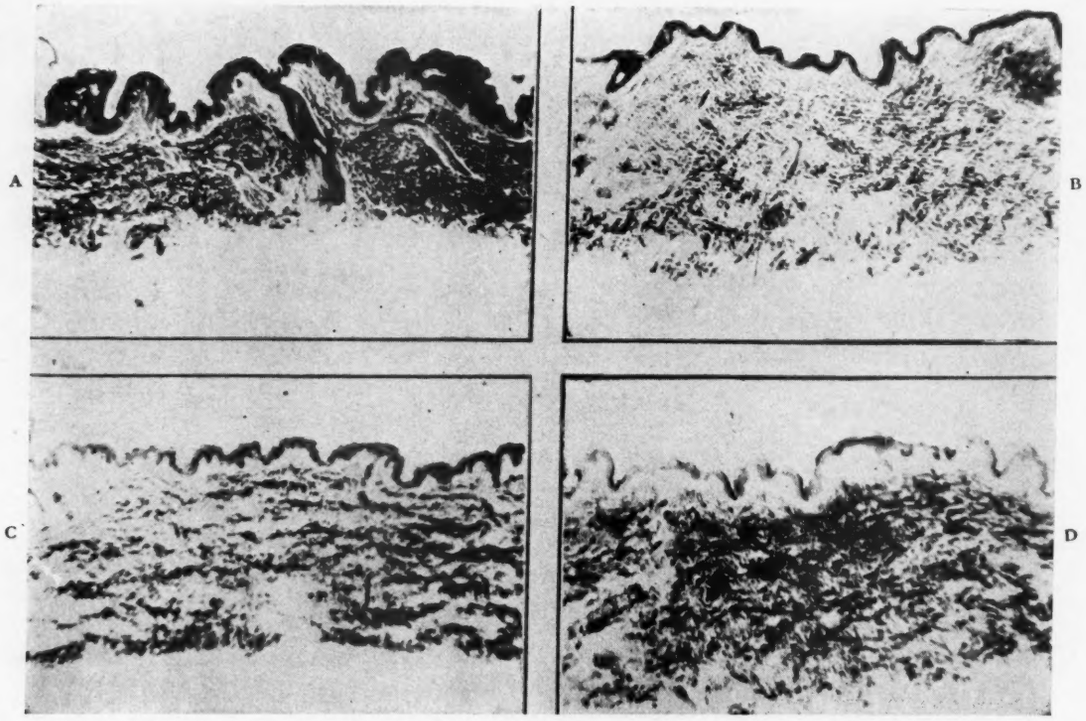


FIG. 2. Sections of thick calibrated skin grafts. X 16. A, graft cut from abdomen of boy, eight years old, about .020 of an inch (.5 mm.) in thickness. B, graft cut from abdomen of woman, age sixty years, pregnant previously; about .025 of an inch (.63 mm.) in thickness. C, graft of male, age fourteen years, cut from abdomen; about .025 of an inch (.63 mm.) in thickness. D, graft of male, age sixty-five years, cut from thigh about .030 of an inch (.76 mm.) in thickness. (From PADGETT. "Skin Grafting." Charles C. Thomas Co.)

for the donor area to be left in such a condition that it is capable of spontaneous regeneration.

To simplify further discussion it might be well to outline a classification of sheet skin grafts:

From a microscopic study of skin grafts, cut by all methods, in my own mind at least, a classification of sheet skin grafts into four types has been evolved: (1) Thiersch (Thiersch's original description of his graft as containing only the epithelial layer probably never was or cannot be cut. There is always some corium: (2) superficial and intermediate "split skin" graft (Blair et al.) one-third to two-thirds of the skin depth; (3) the so-called "three-quarter thickness" skin graft (75 to 90 per cent of the skin depth); and (4) the full thickness skin graft which includes all skin layers.

The following conclusions were reached: (1) The Thiersch graft is cut at a thickness of about .008 of an inch (.2 mm.) to 0.10 of an inch (.25 mm.) in thickness. (2) The "split graft" or superficial intermediate skin graft as cut with the large knife, in adults is usually from .012 of an inch (.3 mm.) to .016 of an inch (.4 mm.). (3) The "three-quarter thickness" skin graft in adults, which is cut with the dermatome and may be predetermined, is from .018 of an inch (.5 mm.) to .022 of an inch (.6 mm.) in thickness. (4) A full thickness skin graft in an adult, according to our sections, varies in thickness from about .030 of an inch (.88 mm.) to .038 of an inch (1 mm.). (Figs. 1 and 2.)

FACTORS

The following factors have to be considered when one selects the type of skin graft to be used:

Whether the Base Is Granulating or Freshly Denuded. If the base is granulating, it is important whether or not it is almost certainly aseptic or probably not entirely aseptic. When freshly denuded and aseptic it may make some difference

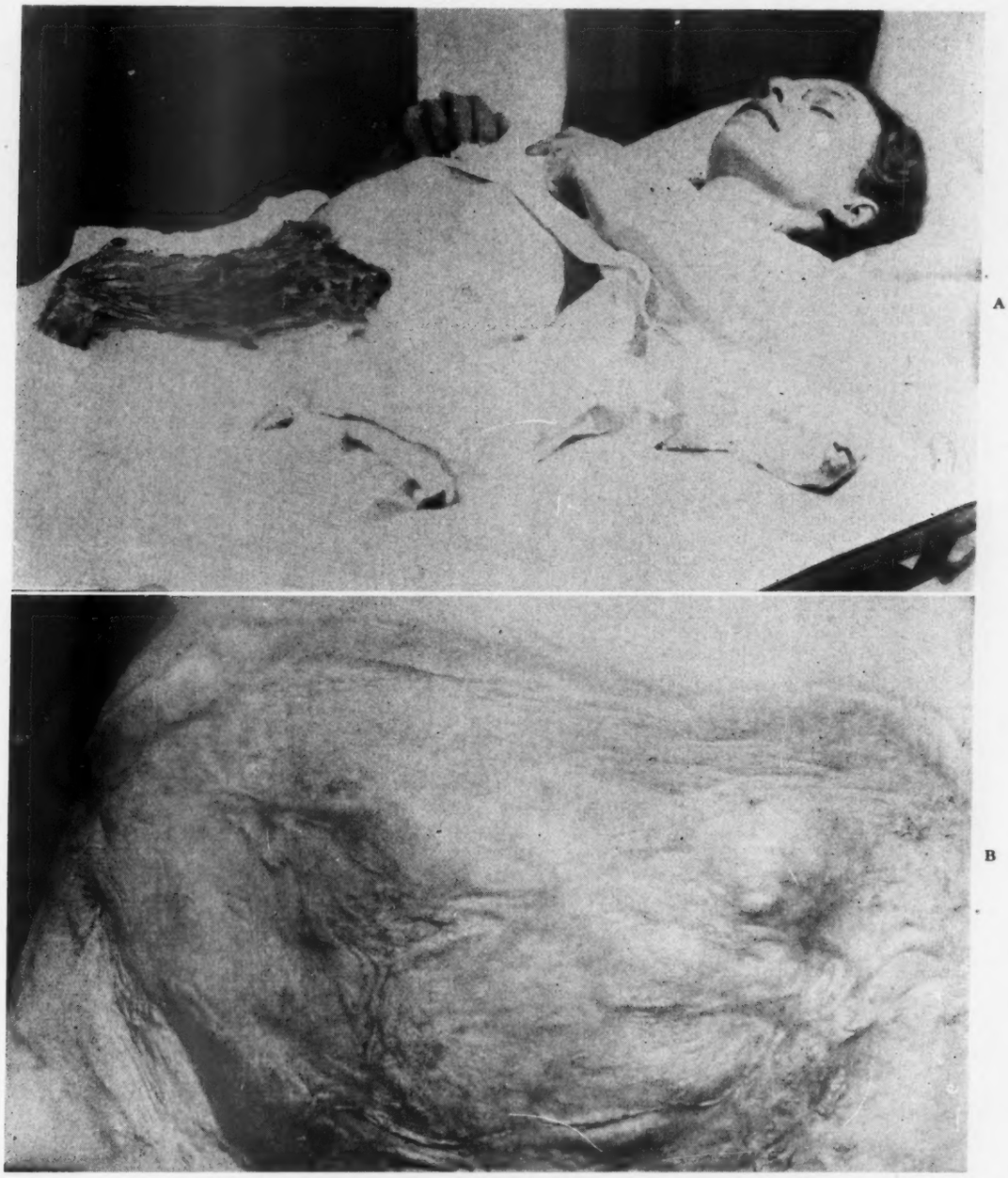


FIG. 3. A, this woman had a large progressively necrotizing ulceration following an abdominal operation. It was eventually stopped after cautery excision. After the whole area was cleaned up with wet dressings the area was covered with a skin graft taken from the thigh and buttocks cut about .010 of an inch in thickness. A good take was obtained. B, the final result after two months.

whether the area is just previously been made surgically or if it is of traumatic origin, as in the latter case the causal factor of the trauma and also the number of hours since the trauma occurred may have some bearing which will influence the selected thickness. (Fig. 3A and B.) One would be inclined to decrease the thickness of the graft somewhat if it were thought that the denuded area probably would not prove to be an aseptic one, or if sufficient time had intervened for the probability of some beginning multiplication of bacteria. (Fig. 4A and B.)

The Location of the Recipient Area. The location of the recipient area is important. Different thicknesses of skin grafts may be indicated on various parts of the face or when one is relining a cavity the thickness

FIG. 4. A, two years before I saw this man he had had large Marjolin's ulcers on both legs excised after he refused amputation which was advised at that time. However, the areas did not entirely heal and beneath the skin was a good deal of deposition of calcium. The scars were completely excised giving a large aseptic denuded base on which were applied large sheets of skin about .020 of an inch in thickness. B, a perfect take was obtained with a good final result.

that one may safely cut a skin graft depends somewhat upon the amount of contamination that one may expect in the bed.

For example, in building a new vagina one has an aseptic field and a relative thick skin graft is advantageous because of minimal contracture while when relining a sulcus in the mouth, because of the relatively unclean bed a thinner skin is the most certain one to "take" and due allowance can be made for subsequent contraction. On the body, legs, arms, hands and feet, when one does not fear a contracture because of the underlying anatomy, and if the condition of the patient is not good, thin coverage only may be the main objective. About joints, the necessity for absence of contracture may lead one to select a graft of considerable thickness when conditions warrant. About the feet, toes, lower legs, palms of the hands and fingers (Fig. 5A to D), the factor of trauma when conditions are favorable, demand grafts of considerable thickness.

Age of Patient. It is hardly necessary to mention the manner in which the age of a patient influences the thickness of a skin graft which may be obtained. Relatively in a child or baby any sheet skin graft that one cuts will be thinner in comparison with the thickness of the skin than of an adult according to the age of the patient. It is well known that it may be very difficult to cut a skin graft from a baby or a small child, thin enough to leave sufficient epithelial elements in the donor area for regeneration.

Donor Area. The location of the donor area may influence the thickness of skin that may be obtained. The skin of the inner

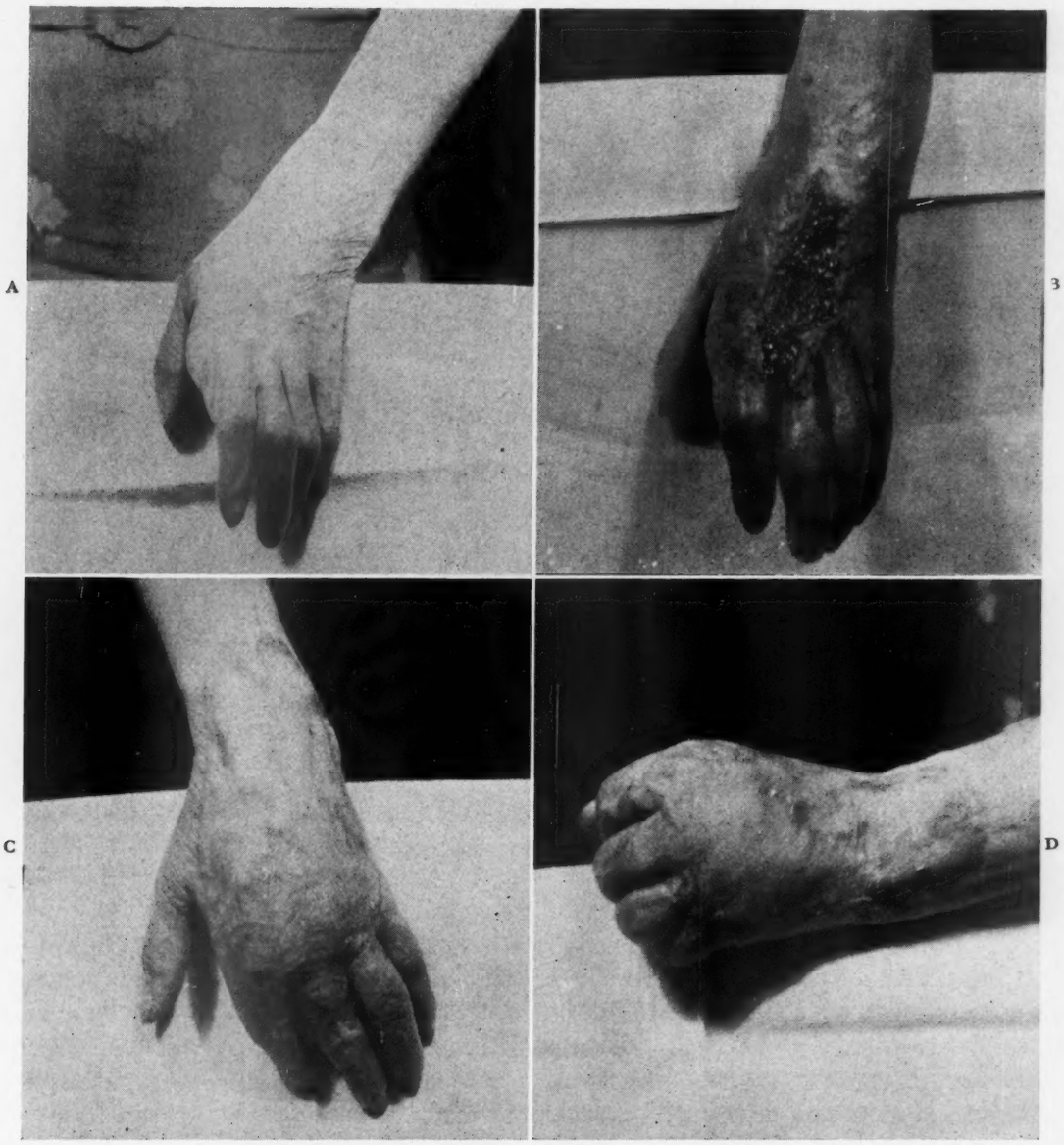


Fig. 5. In this case the ideal thing would have been for the area to have been covered immediately after the mangle burn injury. However, it was neglected for about three months. When she first came to see us her hand was as shown in A. She returned to another surgeon for another operative procedure with the result shown in B. After cleaning up the granulating area it was totally excised down to the tendons and a thick skin graft about .020 of an inch in thickness was placed over the dorsum of the hand with the result shown in C and D. (From Padgett, "Skin Grafting." Charles C. Thomas Co.)

side of the arm and although less so, the inner side of the thigh may be fairly thin, while that over the outer thigh, abdomen and back especially is thicker. In the female such is especially true. When the female has had multiple pregnancies the skin over the abdomen may be almost paper thin.

One can get a rough idea of the thickness of the skin in an individual by making an incision at right angles with the surface with a scalpel and then examining the cross-cut skin as to thickness.

Recipient Areas Difficult to Cover with Skin. A skin graft of any thickness is likely not to "take" on fat. This may be a problem when contractures are released, especially about the anterior chest region of fat women. About one-half "take" of a skin graft may be obtained on diploic bones. This in certain instances may allow

FIG. 6. Example of a very large granulating area due to a burn which was covered with a skin graft about .010 of an inch in thickness with a perfect take of the whole area. The function was good without any further skin grafting.

complete healing over the skull. But as a rule, on bone a skin graft will not take in a sufficient amount to be useful. This is absolutely true when a dependent position has to be maintained or trauma withstood. Over tendons unless the uncovered area is very slight, a skin graft of any thickness is usually not indicated. Such conditions usually call for a skin flap.

LESIONS FOR WHICH SKIN GRAFTS ARE PARTICULARLY APPLICABLE

The areas for which skin grafting are advisable fall into two large groups, (1) the granulating more or less superficial relatively non-aseptic areas, whatever their cause may be, and (2) the healed or nearly healed cicatricial contractured lesions due to various causes which when excised or cross-cut provide an aseptic base. To resurface the former, in an adult it is our custom, almost invariably to use a thin skin graft of about .008 to .10 of an inch in thickness. To resurface and correct the latter with certain exceptions which will be mentioned subsequently, it is our custom to use what we have termed a "three-quarter thickness skin graft." Often the etiology of the granulating areas, the cicatrix or scarred contracture with the exception of one due to excessive irradiation, is not so important as the location. In other words, the principles of the correction often are based upon other factors than that of etiology.

For purposes of illustration it may be well to select certain definite types of lesions which are typical for comment. When a superficial "split" skin graft is used the skin graft is cut with the dermatome or with the large knife by hand, depending upon the size of the area to be covered, the donor area available and which method seems the easiest and the quickest has an influence. In other words, both methods

Fig. 7. A, this man sustained a burn on the back when he was a boy. He was unable to raise his arms and he had a very thick scar over the back. The contracture beneath his axilla was released and the scarring was excised from his back to relieve the feeling of tightness and the tendency to ulceration. In this case three-quarter thickness skin grafts about .022 of an inch in thickness were used. B, final result.

are used according to indications for the given lesion and patient.

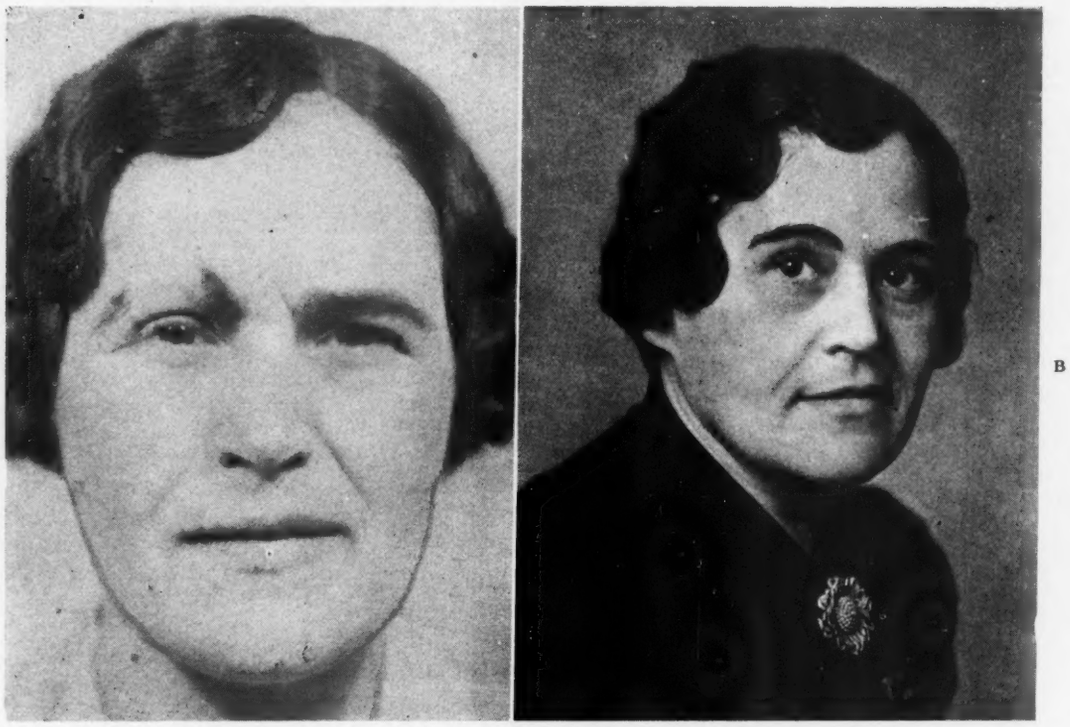
Skin Grafting in Severe Burns. Following a severe third degree burn the lesions seen by the reconstructive surgeon fall largely into two groups:

In the first group are those individuals presenting a large granulating surface in whom the demand is immediate resurfacing.

In the second group of cases, either the base following the preliminary resurfacing has contracted sufficiently to allow a residual contractual deformity, or else the wound has been allowed to heal intentionally by secondary intention with the idea of relieving the contractural deformity at a later date when one has the advantage of an aseptic field which makes it possible to use a thicker skin graft, as such a graft will contract less and will give a better cosmetic result and better protection.

The Unhealed Lesion. As a general rule, the outstanding demand in the unhealed lesion is to clean up the wound as quickly and as thoroughly as possible so that the granulating area can be resurfaced as early as possible. Although a thin skin graft may not be the ideal material, the surgeon has no choice, as the danger of not obtaining a satisfactory "take" with a thicker skin graft is too great. A large amount of the tendency to contracture, however, may be prevented by the early resurfacing, and the period of disability with its economic potentialities can be very materially lessened. (Fig. 6A and B.) On the face it is seldom that temporary resurfacing is indicated. However, it often is indicated over the dome of the skull. A thin skin graft gives a poor cosmetic result and as a rule it will have to be removed and replaced by a thick skin graft to effect the maximum final correction. Therefore, as a rule it is just as well to allow the lesion to heal by secondary intention and allow the field to become a relatively aseptic one so that in the correction one can use the skin graft which will be needed finally. The exact opposite applies elsewhere and particularly to the back of the hand where if possible early movement is a desirable goal.

When the granulating base is relatively new, a large thin graft will show a greater tendency to "take" well if the granulation tissue is not interferred with; but when sufficient fibrosis has occurred to give a firm scar base, after the granulation area has been rather widely excised the chances of a complete "take" with a skin graft of a thickness about three-fourths the thickness



A B

FIG. 8. A, this woman had sustained an injury which had destroyed the right eyebrow and there was a scar extending up on her forehead. A graft was removed from the posterior scalp and all of the fat was removed from the base. Even the lower ends of the hair follicles were cut off with scissors. A skin graft about .020 of an inch in thickness was applied to the forehead. The scalp graft was applied to the eyebrow region. B, final result. (From PADGETT. "Skin Grafting." Charles C. Thomas Co.)

of the skin, are not decreased. Often some of the contracture is relieved and better functional results thereby obtained because of the scar excised and the greater thickness of the skin graft which has been applied.

The Healed Lesion. Formerly when a full thickness skin graft was used to correct a healed defect, one unfortunately had to consider the possibility of a partial or even of a complete failure to obtain a good "take" in about 20 per cent of the operative attempts, dependent principally upon the anatomy of the region.

At the present time, with a few exceptions, for healed or nearly healed lesions the "three-quarter thickness" skin graft is used, one largely eliminates the chances of failure to get a "take." The amount of contracture is minimal and the cosmetic result is good.

When one wishes to correct a contracture about such a region as the axilla, the popliteal space or the elbow, full movement of the extremity is the first consideration. In the axilla and on the neck it may be found that a good "take" with a skin graft is more difficult to obtain because of the difficulty of obtaining uniform pressure but with proper technic in applying the dressing this factor may be reduced to nearly nil. One can largely ignore this difficulty about the elbow or the popliteal space. To correct a contracture of the neck or axilla after making use of any material available for a switch pedicled flap, the application of a graft of "three-quarter thickness" as a rule, is the method of choice. (Fig. 7A and B.) Also about the elbow and about the popliteal space, the groin, the perineal region, or the back of the hand, the thicker type of graft is preferable. For cicatricial contractures of the palm of the hand and the flexor surfaces of the fingers, the thick skin ("three-quarter" or deep intermediate) graft often offers a good functional result. If one uses a thin graft in these areas it will be found that the final contracture is considerable, that the appearance is not

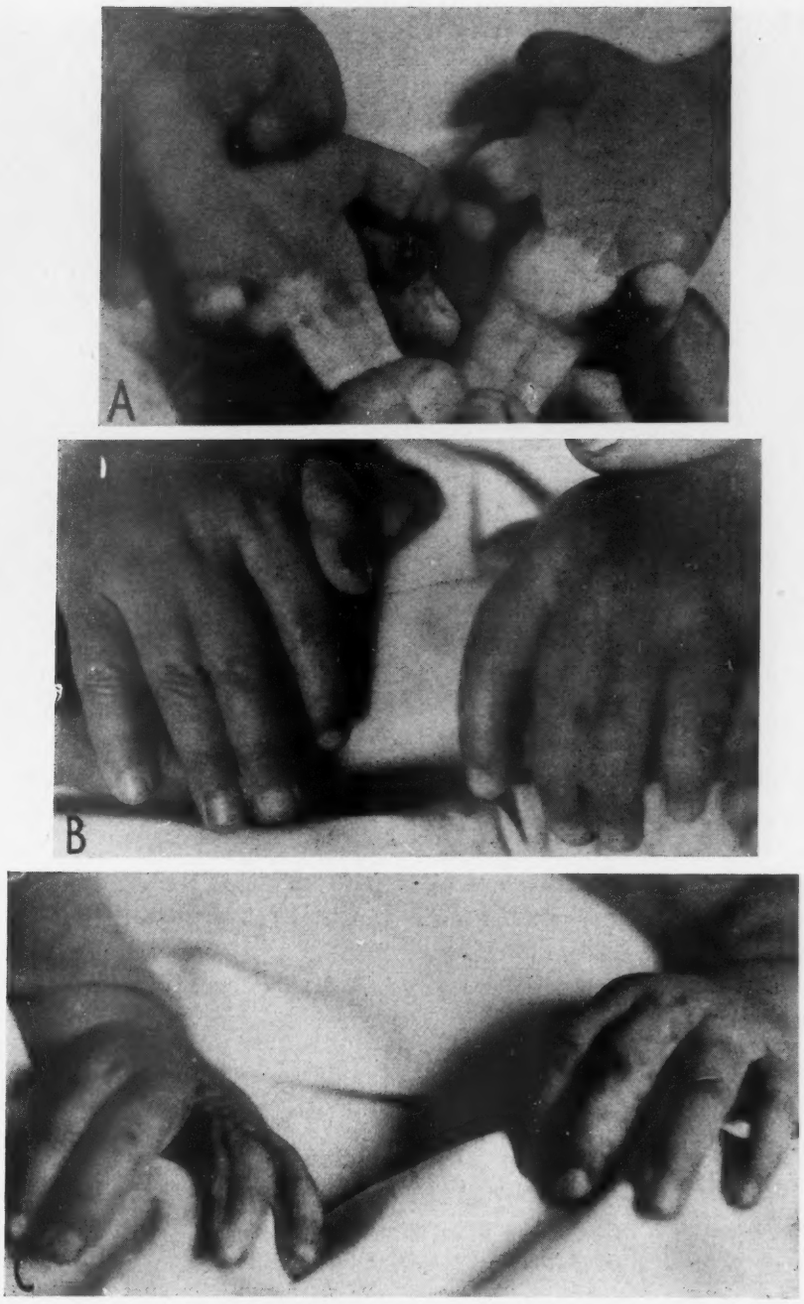


Fig. 9. Example of a full thickness skin graft applied for the correction of web fingers. After a number of years a secondary operation was done to release some scar contracture on the lateral sides of the fingers.

very good, and that in the case of the palm of the hand and the ventral surface of the fingers the protection may not be adequate. On the anterior portion of the neck, a thin skin graft usually contracts from 50 to 70 per cent—too much to correct the contracture—and the appearance usually is not satisfactory. On the neck, the sides of the cheek and over the mandible the deep intermediate or "three-quarter thickness" skin graft should be given preference because it can be cut at a desired thickness and it closely resembles the normal skin in appearance. Some of our most brilliant results have been obtained with large "three-quarter thickness" skin grafts to the neck or face. Probably a full thickness skin graft taken from behind the ear or from the opposite eyelid will most nearly imitate the normal skin when applied over

FIG. 10. A, example of a girl with a large birthmark of the face which has been irradiated. The birthmark was excised and a three-quarter thickness skin graft was applied. B, result one and a half years later. Her appearance is very good with the application of simple cosmetics. (From PADGETT. "Skin Grafting." Charles C. Thomas Co.)

the orbicularis palpebrae muscle for an ectropion of the eye although for large correction, as a rule, insufficient material is available which will give sufficient skin to correct the contracture even if the color of the new graft is not quite ideal. For ectropion of the lips a skin graft of "three-quarter thickness" often is the graft of choice from the standpoint of appearance and function.

When a "three-quarter thickness" deep intermediate skin graft is used on the neck and chin and about the mouth and over the cheek, in some cases a secondary operation is necessary after a period of several months for the purpose of excising the rather heavy scar which tends to form at the juncture of the skin graft with the surrounding normal skin. Moreover, even when the "take" of the "three-quarter thickness" or deep intermediate skin graft is perfect, the possibility has to be considered of having the graft too shiny or in brunettes of presenting a discoloration from pigmentation. Although there is a tendency for the thick skin graft to have a slightly shiny appearance, the grafts that "take" will, without superficial exfoliation, eventually show almost the normal texture of the skin for the region from which the graft was removed. The grafts in which some superficial exfoliation occurs have more of a tendency to pigmentary changes. In pronounced brunettes pigmentation sometimes occurs after a perfect "take."

Eyebrows. Acceptable eyebrows may be made with a full-thickness skin graft from the scalp. The hair will be found to be somewhat sparse and less plentiful than in a normal scalp, but with care in clipping the new eyebrow may be fairly successful. (Fig. 8A and B.) All the fat and even the deepest of the hair follicles should be removed with the scissors when preparing the graft if one wishes to get a good "take."

Web Fingers. In certain congenital anomalies such as "web" fingers and "web" toes, the application of a full-thickness graft offers the best result especially in children. (Fig. 9A, B and C.) Two operations may be required because there is a tendency for a thick scar to form at the junction of the skin graft and the normal skin. In children, full thickness grafts take well. As one does not need much skin it is usually advisable to cut the necessary

diamond-shaped piece of skin from the abdomen.

Birthmarks. "Birthmarks" of the" port-wine" type in adults, do not respond well to radium therapy. The color is obliterated only in a splotchy manner, and telangiectasis and scaly areas usually form. Often the area, if not actually painful, is at least uncomfortable. When the color is dark, the lesion thick or over-irradiated, it has been our custom to excise those lesions *en toto* after which a "three-quarter thickness" skin graft is applied. As a rule, the scar between the normal skin and the graft will be slightly heavy and will need some excision.

The majority of these skin grafts are slightly whiter than the surrounding skin but they show good texture. In a dark brunette one runs a chance of getting some permanent pigmentary changes in the graft. (Fig. 10A and B.) However, this may not be very noticeable after a period of years. With the aid of some "cover mark," powder or rouge or tatooing (Byars), the appearance of the skin graft can be made to approach normal skin very closely. On the whole, as a rule, the result is extremely satisfactory to the victim of this noticeable deformity.

Cavity Grafting. A skin graft should be thin for relining an eye socket and to get the best socket the stent should be specially made, flattened and oval. One does not need much depth to the socket, but all the diameter possible is necessary. For deepening an obliterated gingivolabial sulcus or to release a scar band in the mouth, nostril or pharynx, a comparatively thin skin graft is preferable and one should not fail to remember that about two-thirds more lining should be applied than will be needed eventually to correct the lesion.

Artificial Vagina. One of the most striking uses of the "three-quarter thickness" skin graft is the formation of an artificial vagina. There has been some published work which would indicate that an artificial vagina might be formed by inserting a bare stent in the space between the rectum and the bladder. I cannot believe that such a procedure can be successful in reforming a vagina unless some remnants of vaginal mucosa are present. The formation of an artificial vagina by means of a "three-quarter thickness" skin graft is an easy procedure. It gives satisfactory result and is not dangerous.

Urethra. McIndoe has successfully reconstructed an acceptable urethra for a hypospadias. But in my experience an operation which employs skin flaps is the better operation for most cases of hypospadias. A skin graft urethra contracts and gives a chordee in erection while if proper correction of the chordee is made previous to the transplantation of a skin flap erection will occur without ventral bending.

SUMMARY

To summarize, as a rule, in adults thin skin grafts of from .008 to .010 of an inch in thickness are used to cover granulating areas and to reline cavities such as the eye sockets and sulci in the mouth. "Three-quarter thickness" skin grafts cut from .018 to .022 of an inch in thickness in adults but thinner according to the age of the child, are used after release of healed or nearly healed contractures and to cover most aseptic denuded areas or cavities. Similarly, the "three-quarter thickness" skin graft is used on the neck and face. It will give the maximum cosmetic correction as a rule and insofar as skin grafts are concerned in contradistinction to skin flaps, the minimum contracture if due allowance for contracture is made. In children full thickness skin grafts are used when small areas are to be covered and in web fingers. For the lower eyelid when a small ectropion is present, a "full thickness" skin graft from behind the ear may be acceptable. When a large healed ectropion of the eyelid or lip is to be corrected a non-hairy down area is selected such as the inner side of the arm where sufficient skin may be obtained.

REFRIGERATION IN SURGERY

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THE use of refrigeration in surgery dates back only a relatively few years. In 1941, after several years of animal experimentation, Allen showed clinically that a tourniquet could be applied to a limb and the part distal enveloped in ice to produce adequate surgical anesthesia.[1] This method was particularly applicable to patients who were poor risks suffering from gangrene. In this and the studies that followed refrigeration was postulated to do four things: first, to produce anesthesia; second, to increase the survival time of anemic tissue; third, to control infection; and fourth, to prevent and control shock. Of these postulates only the first has been proven. The clinical studies, as a group, have not been well controlled except for those dealing in reduction of mortality in patients who have had an amputation for gangrene. The experimental studies are better controlled but in many cases have been equivocal.

The experimental evidence may be divided into five subsections. These will be discussed first. The clinical evidence is of a more conglomerate nature and will be presented later.

GENERAL EFFECT OF REFRIGERATION ON TISSUES

The velocity of most biologic reactions varies directly with the temperature. Cellular activity stops at a temperature close to freezing. Conduction in a nerve trunk in warm blooded animals stops between 25° and 30°C.[2] This accounts for the phenomenon of refrigeration anesthesia.

Cooled tissues become anesthetic and their metabolic rate lowered. After exposure to a temperature of 3° to 4°C. for twenty-four to ninety-six hours, the tails of rats show marked degeneration of nerves and muscles in the cooled areas.[3] Low temperatures produce cellular injury by direct effect and by ischemia of the cooled part. The vasoconstriction concomitant with cold results in a lack of oxygen and it is generally agreed that this causes most of the damage. During cooling, there is said to be an accumulation of tissue metabolites which cause reactive hyperemia after the cooling agent is removed.[2]

SURVIVAL OF TISSUES

In his early work, Allen investigated the survival time of extremities subjected to complete asphyxia.[4–8] The ligated leg of a rat survived thirteen hours and that of a dog fifteen hours. The main complication was secondary shock on release of the tourniquet. Allen noted that even slight elevations of the body temperature multiplied enormously the effects of mass ligation. Gangrene occurred earlier and secondary shock on release of the tourniquet was proportionately greater. Reducing the temperature of the ligated part decreased the danger of gangrene and secondary shock. He believed that the best temperature for an asphyxiated limb was 2°C.

Brooks and Duncan[9–11] studied the effects of temperature on the survival time of anemic tissues. Rats' tails were subjected to a pressure of 130 mm. Hg. at temperatures ranging from −5°C. to 40°C. The time for gangrene to develop was recorded. Between 1° and 5°C. the tails would survive over ninety-six hours; at room temperatures they would survive eighteen hours of pressure; and at 40°C. they would survive only three to four hours. Pathologic studies revealed that although gross survival was present, microscopically there was marked fibrous replacement of the muscular and nervous tissues. In another experiment the tails of two rats were subjected to a pres-

sure of 130 mm. Hg. at 30°C. for sixteen hours. This time period invariably resulted in gangrene. One animal was then subjected to a temperature of 40°C. Gangrene began in two hours and was complete in twelve. In the other the tail was kept at 1°C. The tail looked normal in twenty-four hours, but twenty-four hours after it was allowed to return to room temperature gangrene was present. In short, refrigeration increased the life of anemic tissues. This was at the expense of degenerative and fibrotic changes which may have been due to the cold or to the anemia.

CONTROL OF INFECTION

Allen injected rat feces into the legs of cats and dogs.[12] Refrigeration for two to five hours with a tourniquet in place had no effect on the infection. If the extremity were kept in ice for twenty-four to forty-eight hours, there was improvement while the tourniquet was in place but gangrene soon followed its release and the animals died. Also, pure cultures of streptococci were injected into the legs of rabbits. Refrigeration with a tourniquet held the infection down until after release of the tourniquet but ultimately was of no value.

Brooks and Duncan[11] introduced oil of turpentine and cultures of Staphylococcus aureus into the skin of the back of anesthetized dogs. If the wound temperature were kept at 40°C., there was marked inflammatory reaction in twenty-four hours and central necrosis in forty-eight. Controls at 37°C. showed slightly less reaction. At 10°C. there was only slight inflammation after forty-eight hours. In this last group the part was allowed to warm. By ninety-six hours the lesions resembled the control group at twenty-four hours. Thereafter the lesions which had been initially cooled had larger necrotic centers than the control group.

Bruneau and Heinbecker[13] inoculated suspensions of hemolytic streptocci into the subcutaneous tissues and joints of dogs' legs. In some animals the limb was immersed in cold water at a constant temperature of 6°C. while controls were kept at room temperature. The inflammatory response seen in the control animals was absent in the cooled tissues. At room temperature the decrease in the number of bacteria followed a logarithmic curve whereas no significant decrease occurred in the chilled limbs. The authors believed that cooling delayed the rate of destruction of bacteria in spite of the inhibition of bacterial growth which takes place at low temperatures.

CONTROL OF SHOCK

Blalock and Mason produced shock due to hemorrhage by removing 3 per cent of the body weight (one-third of the blood volume) from the femoral artery over a thirty-minute period.[14] Of fourteen controls, five recovered, the average duration of life in the remaining nine being about three and one-half hours. In nine animals whose temperature was raised 3.7°C. the average duration of life was five and one-half hours and all died. In eight animals chilled to lower the rectal temperature to 12.3°C. the average duration of life was eleven and one-half hours and all these also died. In this experiment the application of cold did not increase the chance of survival but did double the survival time. Similarly blood was removed from dogs until the shock level of blood pressure was reached (75 mm. Hg.). Eight animals were heated to raise the body temperature 3.6°C. and fifteen cooled to an average of 6.6°C. Those exposed to cold lived twice as long and one of the refrigerated animals survived.

Duncan and Blalock[15] demonstrated that freezing during a crushing period protected the animals considerably from shock and local fluid loss. The metabolism of the tissues was reduced and less injury resulted from the inadequate blood supply. Refrigeration after crushing had little or no influence.

EFFECT OF COOLING ON WOUND HEALING

Large and Heinbecker[16] produced clean wounds in dogs' legs. The extremities were

then kept either at room or cooled temperatures. During the healing phase biopsies were taken and tensile strengths measured. They found that during the cooling period there is no cellular response to the trauma of the incision. At any given period during the healing process the cooled incisions showed delayed healing as evidenced by decreased tensile strength. The degree of delay in healing was roughly proportional to the duration of the cooling period. Cooling a limb for forty-eight hours was shown to result in sufficient tissue damage to cause a marked effect on wound healing for more than two weeks. In addition it was found that prolonged refrigeration (seventy-two hours) followed by delayed suture resulted in a higher incidence of infection than would have been the case if cooling had not been used.

CLINICAL EVIDENCE

The first clinical report appeared in 1941.[17] Fifty-seven amputations were performed on forty-five patients suffering from gangrene. There was an overall mortality of 15.5 per cent. Crossman et al. stated that the anesthesia was adequate, that necrosis was limited and that infection was stemmed. They believed that refrigeration did not weaken the barriers to infection, did not reduce the local vitality of tissues and did not create the additional dangers of thrombosis and embolism.

McElvenny in the same year[18] said that patients undergoing amputation under refrigeration anesthesia have no pain and do not need additional anesthesia. The operation is practically bloodless, shock is greatly diminished, the mortality rate is lower and the results are as satisfactory as by any other method. Two of the case histories presented are significant. One was that of a man who sustained a crushing injury with traumatic amputation of both legs at the knees. He was in profound shock. The stumps were packed in ice for fifty-eight hours while he was treated for shock and pneumonia and prepared for surgery. Secondary amputation was done under ethylene anesthesia. The stumps were cold and firm, the muscles red and healthy and blood clots absent. Primary healing took place. There was pain in the stumps prior to cooling but none after. The second patient was a seventy-eight-year old man with wet gangrene of the lower extremity. His leg was kept in ice for twenty-eight days. No tourniquet was used. There was no gross damage to the skin and there was no pain. A tourniquet was applied and a mid-thigh amputation performed. Recovery was uneventful. McElvenny thought that cooling without a tourniquet was bacteriostatic, prevented toxic absorption and alleviated pain.

O'Neil[19] reported the experiences at the Boston City Hospital. From 1930 to 1939, there were 162 cases of major gangrene deemed inoperable. The mortality rate of these patients was 100 per cent. The mortality rate of 270 patients with major gangrene subjected to amputation was 53 per cent. From 1940 to 1943, fifty-four patients were prepared with refrigeration; four died before operation. Of the fifty operated patients sixteen died, a mortality rate of 32 per cent. There was then a 21 per cent reduction in deaths. O'Neil stated, "The immediate salutary effect of chilling of tissues on the more prominent signs and symptoms was most striking. Relief of pain was observed in every case and without the aid of the customary medication. It is well known that sudden arterial occlusions, as from an embolism, are most painful and that great discomfort persists for many hours. . . In this group the relief of pain has been most dramatic. . . Shock was practically absent in fifty cases. The progress of gangrene and sepsis was notably inhibited." One of his patients was a ten year old boy in whom gas gangrene of the upper extremity, axilla and chest wall appeared after a compound fracture of both bones of the forearm. When the boy was in extremis a tourniquet was applied to the upper arm and the extremity packed in ice. His condition improved remarkably. Am-

putation was performed twenty-two hours after onset of refrigeration. Convalescence was uneventful. On the other hand, two of the patients died of gas gangrene which developed in the stump.

Richards[20] was the first to present case histories with pathologic studies. His first patient was a fifty-two year old woman with an embolus to the lower extremity. Papaverine, lumbar sympathetic block and femoral artery exploration did not result in improved circulation. On the third postoperative day a line of demarcation could be felt. On the fifth postoperative day the limb was refrigerated and refrigeration continued for two weeks. The limb did not become grossly viable and a low thigh amputation was performed. Grossly, the limb was gangrenous but infection and necrosis were minimal. Microscopically, the muscles showed marked degeneration. The small vessels contained very few cells. The nervous tissue showed mild degenerative changes and there was necrosis of the dermis. The second patient was a seventy-year old man with painful ulcers of the foot due to arterial insufficiency. A tourniquet was applied, the limb refrigerated for two and a half hours and superficial nerve section performed. The leg was allowed to return to room temperature over four days. Leg pain reappeared, the toes looked as though they were about to become gangrenous and mid-thigh amputation was performed. Degenerative changes were again seen in sections of nerve and muscle.

A brief review of the literature reveals five other clinical applications of refrigeration. It has been used as a temporizing measure in acute vascular occlusions and in traumatic arterial spasm. Cold has been tried in infections in the presence of an inadequate blood supply. O'Neil[19] described a young man with scleroderma and a deep infection of the palmar fascial spaces. Heat resulted in rapid spread of sepsis with bleb formation. Packing the forearm and hand in ice resulted in gradual recovery. Webster, Woolhouse and Johnston[21] noted tremendous tissue reaction when patients with immersion foot were exposed to room temperatures. There was edema, ecchymosis and bleb formation suggestive of the reaction of feet with impaired blood supply that are developing gangrene. Reduction of temperature by the application of icebags was the single best therapeutic measure at the time. O'Neil [29] has refrigerated the lower extremity of several patients with deep venous thrombosis. In a small series so treated none needed femoral vein ligation. Mock[22] used refrigeration anesthesia in twenty-seven patients for the cutting of small split thickness grafts.

TECHNIC

The method is essentially one of combined ligation and refrigeration. The tissues are refrigerated, not frozen. If the tissues be cooled a little below 0°C., freezing takes place with irreversible cellular changes. A skin temperature maintained between 8° and 10°C. is most desirable. When the skin is kept at 8°C., the muscles are usually 9°C. and the bone 10°C.

The application of the tourniquet itself is very important. Rubber tubing 10 to 12 mm. in diameter is the best material for ligation. Allen showed[12] that wide bands such as Esmarch bandages, by traumatizing wide masses of tissue, contribute to a greater degree of secondary shock and injure nerves more than do narrow bands. The site for the tourniquet is surrounded with ice bags for fifteen to twenty minutes prior to application. This minimizes discomfort. Two turns of the tourniquet are made at the chosen site as tightly as possible. Care is taken not to pinch the skin. For a low thigh amputation the tourniquet is applied at the junction of the upper and middle thirds of the thigh. Other sites are chosen as the dictates of the case demand.

The extremity is packed in shaved ice up to and including the site of the tourniquet. The whole is encased in rubber sheets or in a box. Precautions should be taken to

allow drainage of water. The ice should be checked to see that the anterior parts of the extremity remain covered. Skin temperatures may be checked with an ordinary laboratory thermometer.

In the average patient it takes two and a half to three hours of icing to allow a painless amputation. In thin limbs this time is decreased and in fat limbs increased. There is no especial need for hurry. The tourniquet and ice may remain in place for twelve hours and even more without change during operation and in healing.

Morphine is seldom if ever needed. Thirty cc. of whiskey is excellent for the patient both pre- and postoperatively.

When the desired anesthesia has been obtained and when the patient is in condition for operation, he is brought to the operating room with the limb still packed in ice. The ice is not removed until the operating team is ready to make the incision. The limb is taken out of ice and the skin prepared. For the usual elderly patient a circular incision is made at the level of the upper border of the patella and the muscle and bone layers staggered. The large vessels are tied (both absorbable and non-absorbable suture material has been used) and the tourniquet released. Other bleeding points are then caught. Closure is simple; the deep fascia is approximated with interrupted sutures and the skin closed similarly. No drains are used. If these be needed, the stump is left open instead. Skin traction is always used when the stump is left open and frequently when it is not.

After the tourniquet is removed, the circulation is seen to return promptly. No thrombosis is apparent. The blood appears normal. The muscles are somewhat brighter in appearance than usual.

Essentially the same technic is used in lower level amputations and in amputations of the upper extremity.

The operation is without pain and without shock. Pulse and blood pressure levels remain constant. Postoperative nausea, vomiting and pain are not experienced.

The stump is packed in ice bags and the temperature gradually allowed to return to normal. Ordinarily ice bags are kept on for two days. The patient is allowed out of bed on the first postoperative day.

Most wounds heal by first intention. "The percentage of first intention healings is comparable to that after similar operations done under other anesthetics."[19] Incisions in refrigerated foci heal more slowly than in non-refrigerated places. Hence the skin sutures are kept in for fifteen to twenty days.

The "dog ear" protrusions at each side of the stump gradually retract. A comfortable stump is obtained and one that will well bear a prosthesis. If traction is not used postoperatively the end of the femur in a small number of cases will gradually become subcutaneous at the lateral aspect of the stump.

CONCLUSIONS

As in many problems in medicine there is a discrepancy between what was postulated, what was found in animal experimentation and what was found in actual practice. The problems of the original postulates remain unsolved, except for the actual production of anesthesia. The chief difficulty is in the dearth of well controlled clinical studies.

The question whether refrigeration prolongs the survival time of anemic tissue remains unanswered. The evidence tends to show that it does. The blessing is not unmixed because of the fibrous replacement of nervous and muscular tissue. The only clinical report with pathologic studies (Richards[20]) is equivocal because arterial insufficiency was established before refrigeration was applied.

The bacteriostatic action of cold *in vivo* is on a weak footing. In all the experimental studies cold was of no value. Clinically, it was. O'Neil's demonstration[19] of the value of cold in a palmar infection in a patient with scleroderma and in a case of gas gangrene and on the other hand the appearance after refrigeration of gas gangrene in

the stumps of two refrigerated limbs merely outlines the ramifications of the problem.

The published case histories[17–19] praise the value of cold in shock. Blalock's studies tend to confirm this although his results are not conclusive.

In the elderly, toxic patient with gangrene and sepsis, amputation with a tourniquet and refrigeration gives excellent results. Here is the chief indication for refrigeration amputation. Pain and shock are eliminated and the operation is performed in a bloodless field. Even then one might wonder whether the tourniquet is not the chief reason for this. If such a patient had a tourniquet applied and received general treatment without refrigeration, when amputation were performed would the results be comparable? The work of Adolph[23] among injured Chinese soldiers suggests that they would be. To those who have seen amputations performed under ice and tourniquet this is unlikely because there is yet no other single method for combating shock, holding infection in abeyance and producing anesthesia.

SUMMARY

The experimental and clinical evidence for the value of refrigeration in lengthening survival time of anemic tissue, controlling infection and preventing shock has been outlined. A technic for refrigeration amputation is presented. Final conclusions can not be drawn and must await more detailed and controlled studies.

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SOURCE OF NERVE AUTOGRAFTS IN CLINICAL SURGERY*

TECHNIC FOR THEIR SUTURE

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THERE is ample evidence to show that the most favorable type of graft for the repair of a nerve defect is the autograft. It is true that in the experimental animal good functional recovery may occur following the use of homografts that are fresh, stored in saline solution, Ringer's solution[9] or serum, or even fixed in formalin.[13] But the incidence of failure of such grafts is too great to risk their use in man.[10,12] Satisfactory results have been reported with dehydrated nerve grafts in the experimental animal[14] but results obtained from their clinical use have not yet been published.

There is no doubt that autografts are more successful in the experimental animal than homografts.[13] Moreover, there is some indication from our experimental work that cable grafts are superior to single thick grafts for the repair of defects in large nerves. The strands of the former are more readily vascularized and necrosis within the graft is less apt to occur. As a matter of fact, single autografts could not be used for the repair of defects in the major nerves in man inasmuch as there is no justification for sacrificing one major nerve for another unless there existed the unusual circumstance in which the nerve to be employed as the graft were from an amputation stump or otherwise of little or no use to the patient. The use of autografts presents two important advantages over homografts. First, one would thereby avoid blood group incompatibility, a possible factor in accounting for the necrosis of homografts. Second, one would eliminate acquired active immunity of host to homograft tissue which may be responsible for the dismal results obtained with nerve homografts just as it seems to explain the destruction of skin homografts.[3]

Davis, Perret and Carroll[1] have expressed the opinion that cable grafts, in which thin nerves are used to form a cable the caliber of the nerve to be repaired, are "doomed to failure because of the technical difficulties of suture." It is true that the use of any form of thread (silk, wire, etc.) for the purpose of suturing a cable graft results in considerable damage to the strands of the graft and, all in all, very unsatisfactory unions. However, the recent introduction of plasma clot for the purpose of forming and suturing a cable graft[13] makes it possible to circumvent these "technical difficulties of suture" and places the use of cable grafts on the agenda of the day. Davis and his associates consider that "it is the homogenous type of graft which is most applicable in Army general hospitals which are amputation as well as neurosurgical centers." However, experimental and clinical experience weighs heavily against this recommendation.

Granted then that the autograft alone should be employed the question arises as to which nerves should be sacrificed for use as grafts. It has been demonstrated that functional efficiency after regeneration of nerves depends to some extent upon the fibers attaining a size which approximates their normal diameters.[7] If the size of the Schwannian tubes of the nerve graft strictly limits the caliber of the downgrowing axis cylinder, one might conclude that grafts taken from sensory nerves would be unsuitable for the repair of motor nerves since they contain fewer large nerve fibers and Schwannian tubes than the latter. (Figs. 1 and 2.) It is known, for

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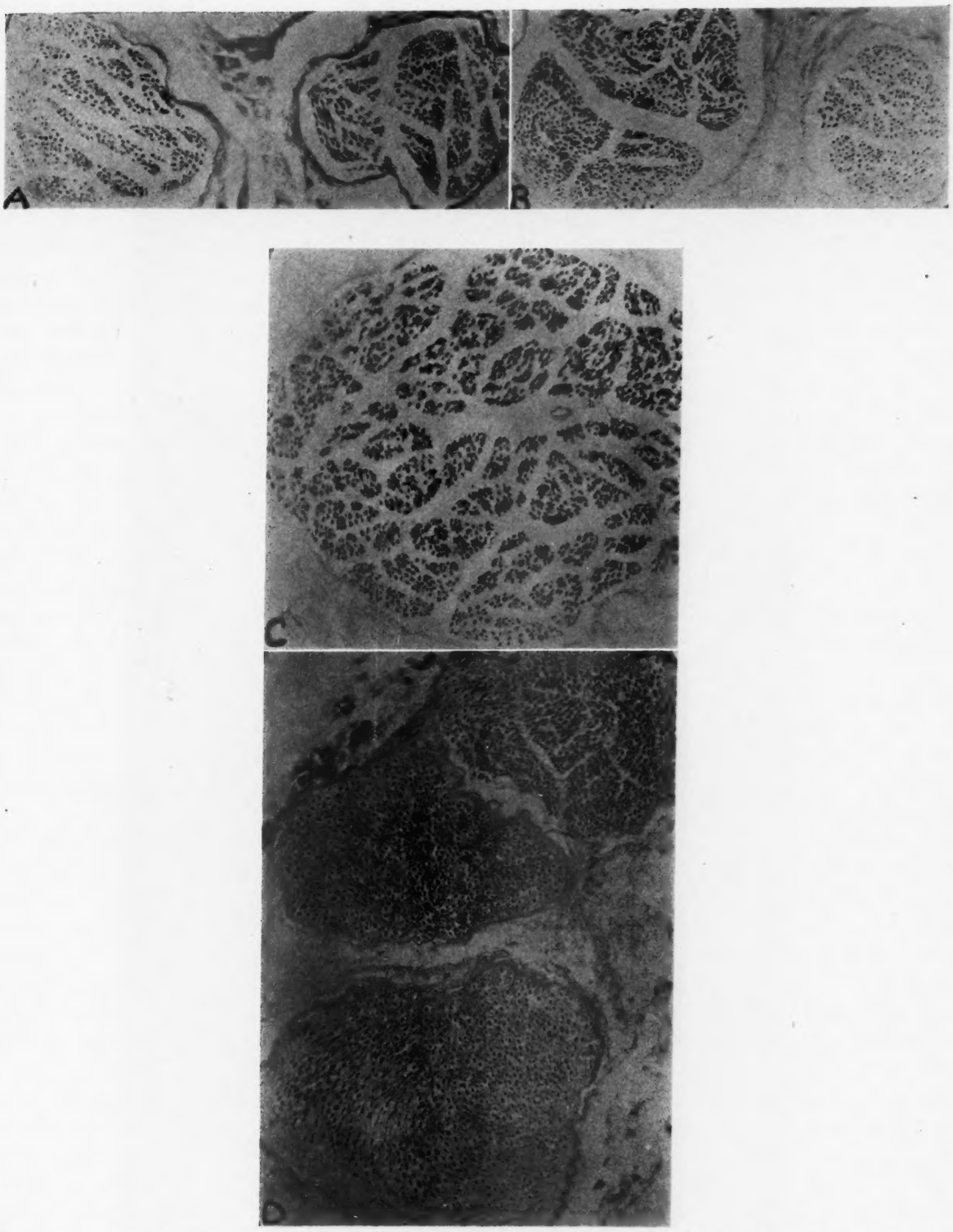

Fig. 1. Gros-Bielschowski preparations showing axis cylinders of medial (A) and lateral (B) antibrachial and lateral femoral (C) cutaneous and intercostal (D) nerves. The intercostal nerve contains a somewhat greater number of large axis cylinders but the difference is not very marked.

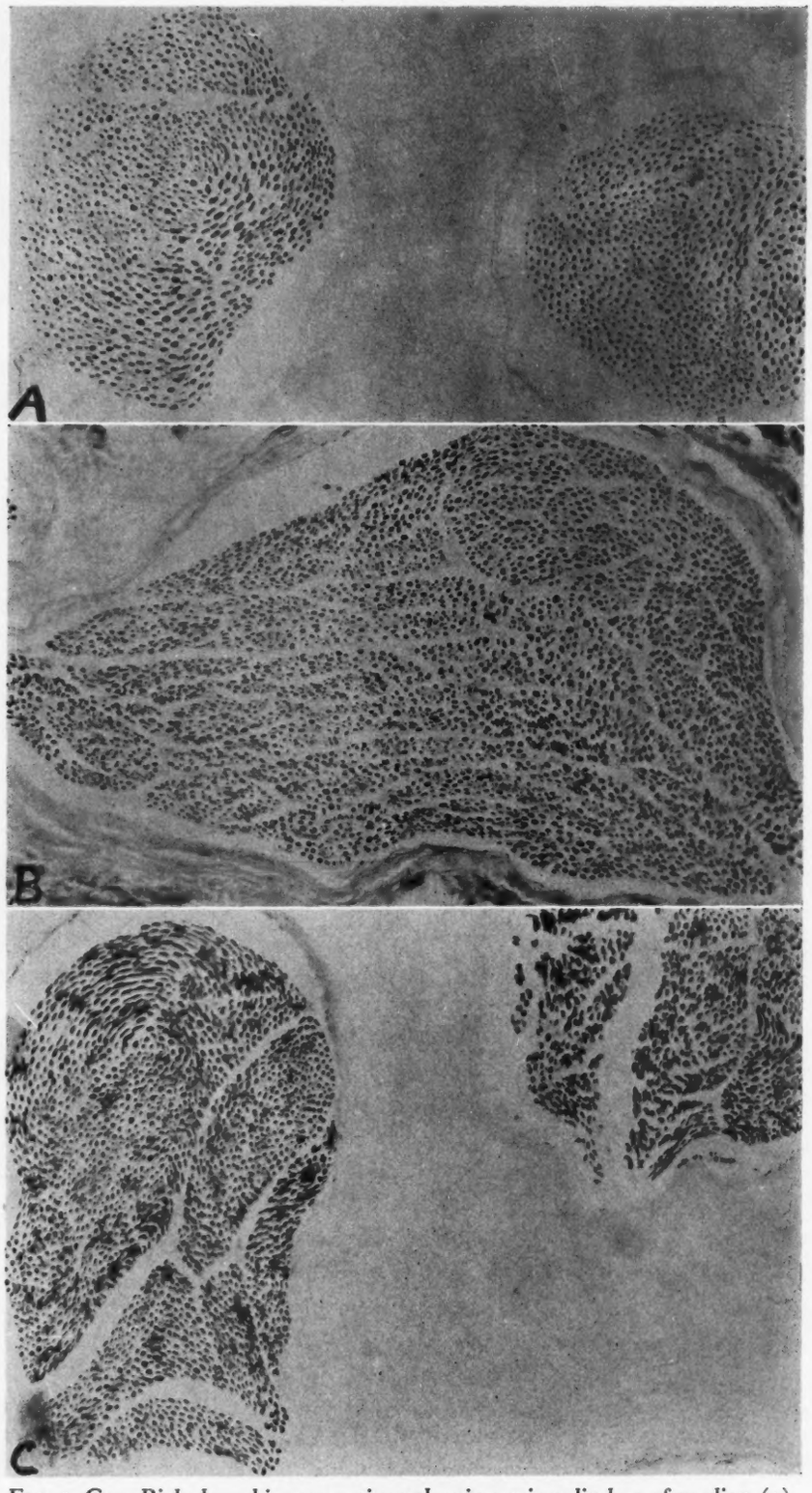

FIG. 2. Gros-Bielschowski preparations showing axis cylinders of median (A), ulnar (B) and radial (C) nerves. These nerves contain a somewhat greater number of large axis cylinders and correspondingly larger Schwannian tubes than the nerves shown in Figure 1. Whether or not such differences would prove to be important in the maturation of regenerating nerve fibers and in subsequent functional recovery remains to be determined. All nerves shown in Figures 1 and 2 were taken from an adult subject and the magnification in all instances is x 120.

example, that fibers regenerating into the distal segment of a nerve containing much smaller fiber pathways than the proximal segment are restricted in their maturation to an appreciable degree.[4] However, Simpson and Young[11] have shown that although very small Schwannian tubes in the peripheral stump do restrict the diameter of the entering nerve fiber, the nature of the terminal fiber connection made also controls the growth of the nerve fiber. Working with rabbits, they used strips of splanchnic nerve which contain many small medullated fibers, as grafts for somatic nerves which have considerable numbers of large nerve fibers. The axones were able to grow through the graft and reach the peripheral end organs. These fibers were found to have become nearly as large as those occurring in pieces of somatic nerve similarly grafted. They conclude that the restrictive influence of moderate-sized Schwannian tubes of nerve grafts is not severe and "though further evidence on this point is desirable the indications are that in man a piece of cutaneous nerve used as a graft in a motor nerve would not unduly restrict the growth of the motor fiber."

From the practical standpoint there is only one alternative to the use of cutaneous nerves as autografts in man and that is the employment of intercostal nerves. The intercostal nerves contain a somewhat greater number of large nerve fibers than purely sensory nerves, (Fig. 1.) Whether this difference is of practical importance in grafting would have to be decided on the basis of comparative studies in man. In the present state of our knowledge and in view of the urgency of the problem of nerve grafts, particularly in cases of war injuries, it seems justifiable to employ cutaneous as well as intercostal nerve grafts in man.

The purpose of this study has been to determine the lengths and diameters of various nerves available for use as grafts, the surgical approach to them and an estimate of the handicap resulting from excision of the nerves. The diameters of the major nerves of the body at several different levels have also been measured. On the basis of the information dealing with nerve size it is possible to estimate the number and length of the various nerve segments necessary for the repair of defects of different magnitudes in the major nerves of the body. The length of the available nerves obtainable for grafting and their calibers will vary with the height of the individual and the degree of his physical development. The figures listed represent average measurements of nerves dissected bilaterally in a series of six cadavers of adult subjects and from observations made during instruction in the anatomy laboratory. The diameters recorded are obviously somewhat different from those which will be found at operation in view of the postmortem changes that occur in the cadaver. Nevertheless, the variations will not be sufficiently great to nullify their intended use.

The choice of particular nerves removed to be used as grafts depends on several factors. The ease of surgical exposure of the nerves, their diameters and available lengths and the degree of disability or annoyance caused by the resultant anesthesia or scar are among the considerations which govern the selection. Incisional scars over bony prominences or areas subjected to pressure such as the dorsum of the foot should be avoided lest pain or ulceration follow. Moreover, the occurrence of large anesthetic areas on parts of extremities exposed to repeated trauma such as the feet would be undesirable because of the risk of trophic ulceration. The creation of sensory loss to the fingers is, of course, contraindicated because the resultant impairment of position sense and object recognition which constitutes a serious handicap. In certain cases the choice of a nerve for grafting will be partly dictated by the position of the patient on the operating table. However, when the need is great this limitation can be overcome by changing the patient's position during the course

of the operation in order to make the necessary incisions.

The areas of sensory deficit following excision of the various cutaneous nerves which might be chosen for grafts is shown in Figure 3 in which is also indicated the incisions used for exposing the nerves. The fields shown are smaller than the maximal sensory area of the nerve because of the overlap between adjacent nerves as demonstrated by Foerster.[2] An advantage of employing the intercostal nerves as grafts would be that alternate nerves could be obtained, in which case, the overlap of nerves would produce little if any loss of sensation or of motor function of the intercostal or abdominal muscles.

These considerations have guided us in formulating recommendations as to the various nerves which might be used for grafting. In dealing with an individual case one must always consider the possible gain from an operation against the counterweight of the handicap resulting from the excision of nerves to be used as a source for the graft. It is hoped that the suggestions may prove helpful in practice although they should not be considered as final. Judgment as to the most suitable nerves for grafts will have to be tempered by actual extended clinical experience.

The intercostal nerves from the sixth through the twelfth thoracic may be freed from the angle of the ribs outwards for a distance of 15 to 18 cm., generally to the mid-axillary line. Beyond this point they branch too much for use. These nerves at higher levels are more difficult to obtain because of the interposition of the scapula. Each intercostal nerve may be found close to the inferior border of the rib, between the external and internal intercostal muscles. The exposure of the nerve may be made at the scapular line which is just lateral to the paraspinal muscles. The skin and superficial muscles are incised over the rib and then retracted to expose the external intercostal muscle, the fibers of which course downwards and outwards. An incision through the external intercostal muscle will expose the nerve close to the lower border of the rib. Care must be taken to avoid entering the pleural cavity. The nerves may then be freed backwards and forewards for the desired lengths. A skin flap with its base running along the course of a rib may be used to expose four to six intercostal spaces. The nerves vary from 1 to 2 mm. in diameter. Alternate intercostal nerves should be chosen in order to minimize the ensuing motor and sensory loss.

The branches of the intercostal or any other nerve that is chosen must be taken with the parent trunk that is to be used for the graft provided that an equal length of the branch can be freed. Otherwise, during the process of regeneration the axis cylinders may wander out along the Schwannian tubes of the branches which have been cut short and become lost in the surrounding tissue. In order to avoid this loss of axones the branches as well as the main trunk of the graft must make end-to-end contact with the peripheral stump of the nerve that is being repaired. A nerve that has profuse branchings which are difficult to follow should, therefore, not be used as a source for a graft.

One of the most favorable of the cutaneous nerves from the standpoint of its accessibility, available length and diameter is the sural nerve (S1, S2) which is formed by the union of the medial sural cutaneous branch of the tibial with the anastomotic branch of the common peroneal nerve. The nerve averages 2 mm. in diameter and may be easily exposed by a longitudinal incision along the lateral border of the Achilles tendon about 10 cm. above the tip of the external malleolus. The nerve may then be freed upwards and downwards for a total length of approximately 25 cm. or more and is relatively free from branching over this stretch. The external saphenous vein lies in close proximity to the nerve and both are superficial to the deep fascia during most of their course. It supplies a small part of the lateral dorsal surface of the foot and calf with sensation, the deprivation of which is of no significant consequence.

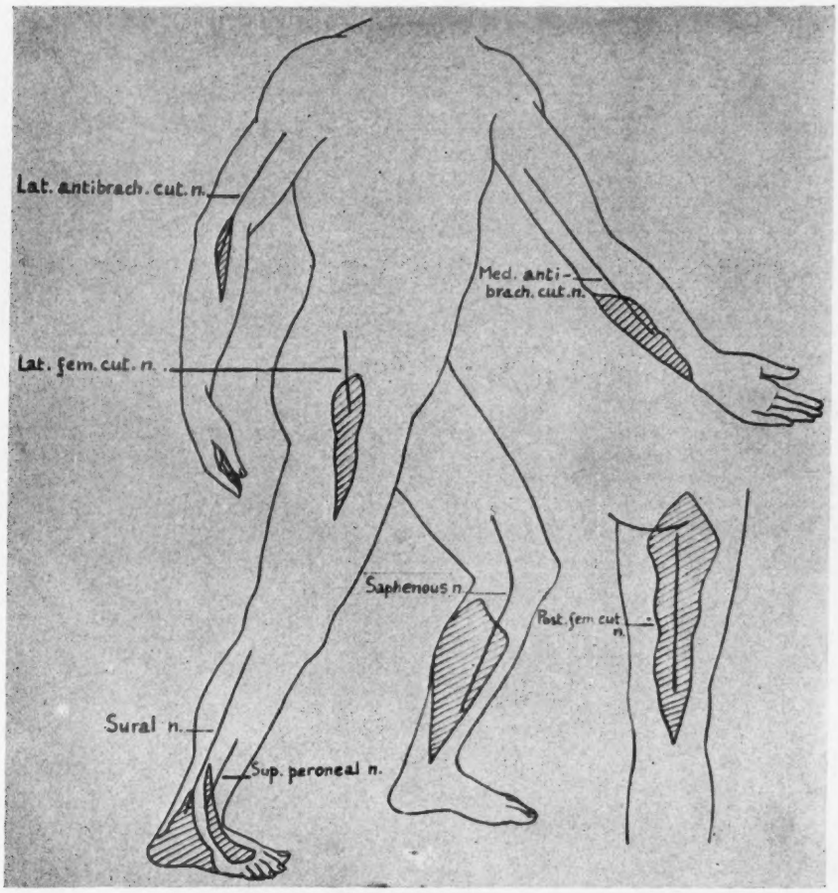

FIG. 3. The sites of incisions for exposure of the various cutaneous nerves which might be used as a source for cable grafts is indicated by heavy solid lines. The autonomous areas, which represent the zones of sensory deficit following severance of the nerve, are shown.[2] The autonomous area (supplied exclusively by one cutaneous nerve) is, of course, much smaller than the maximal area (which remains when all neighboring nerves to this region are severed); this has been demonstrated by Foerster.

The lateral femoral cutaneous nerve (L2, L3) is approximately 2 mm. in caliber as it passes from under the inguinal (Poupart's) ligament. It enters the thigh within 1 to 2 cm. of the attachment of Poupart's ligament to the anterior superior iliac spine. The nerve is rather flat in this region and tends to adhere to the superficial surface of the sartorius muscle. The fasciculi of the nerve course downwards and outwards whereas those of the muscle run downwards and inwards. The nerve is exposed by an incision just medial to the anterior superior iliac spine. It divides into several branches within a few centimeters distal to Poupart's ligament One of the main branches of the nerve, approximately 1 mm. in diameter, may be obtained for a total length of 15 to 20 cm. Following its excision the loss of sensation over the anterolateral region of the thigh constitutes no handicap to the patient.

Approximately 15 cm. of the posterior femoral cutaneous nerve (S2), which is 2 mm. in diameter, is available for grafting. The nerve may be exposed by a longitudinal incision commencing superiorly at the gluteal crease on a line from the tuberosity of the ischium to the middle of the popliteal fossa. Its course bisects the hamstring muscle mass almost exactly. The nerve lies at a rather deep plane close to the fascia lata in which it may be enmeshed. Because of the absence of exact guiding landmarks and the fact that it blends with the fascia over the hamstring

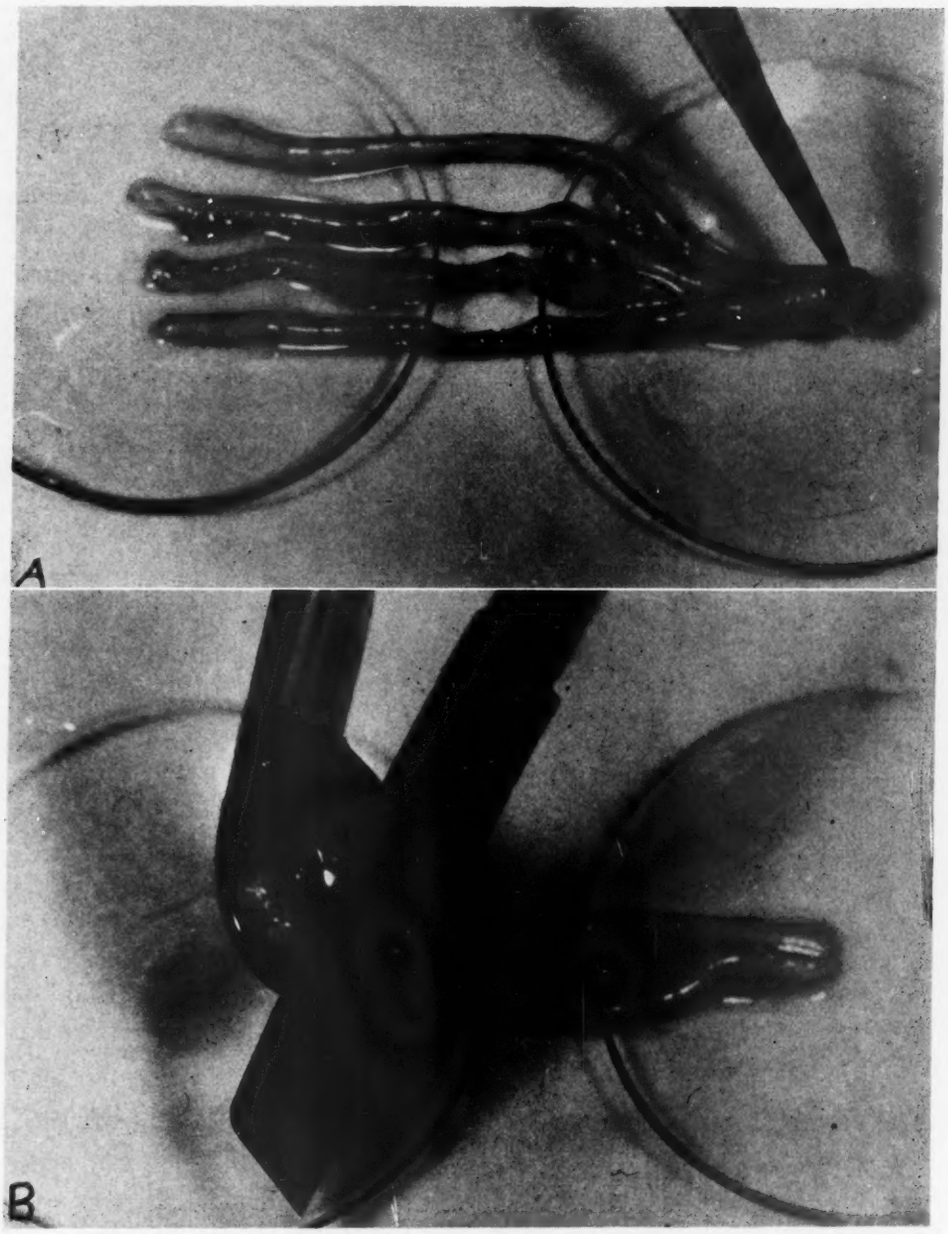

FIG. 4. The technic of forming a cable graft is shown. Plasma is dropped on the terminal centimeter of the nerve strands placed in a watch glass and the ends are fashioned into a cable (A). Five to ten minutes are allowed for firm union to occur. After the other ends have been united similarly, thin slices are excised with the aid of the special nerve holder and a razor blade mounted on a needle holder (B). Flat cut surfaces for contact with the host nerve are thus obtained.

muscles the nerve is somewhat more difficult to identify than other cutaneous nerves.

The superficial peroneal nerve (L5, S1) is obtainable for a length of 15 cm. after supplying motor fibers to the peroneus longus and brevis. The diameter of the nerve or of its two branches collectively (medial and intermediate dorsal cutaneous nerves) is 1 to 2 mm. The nerve may be exposed by a longitudinal incision centered about 12 cm. above the lateral malleolus. It lies in the groove between the peroneal muscles and the extensor digitorum longus at the junction of the lateral third and the medial two-thirds of the anterolateral quadrant of the leg.[8] The nerve emerges from the deep fascia at this point. It

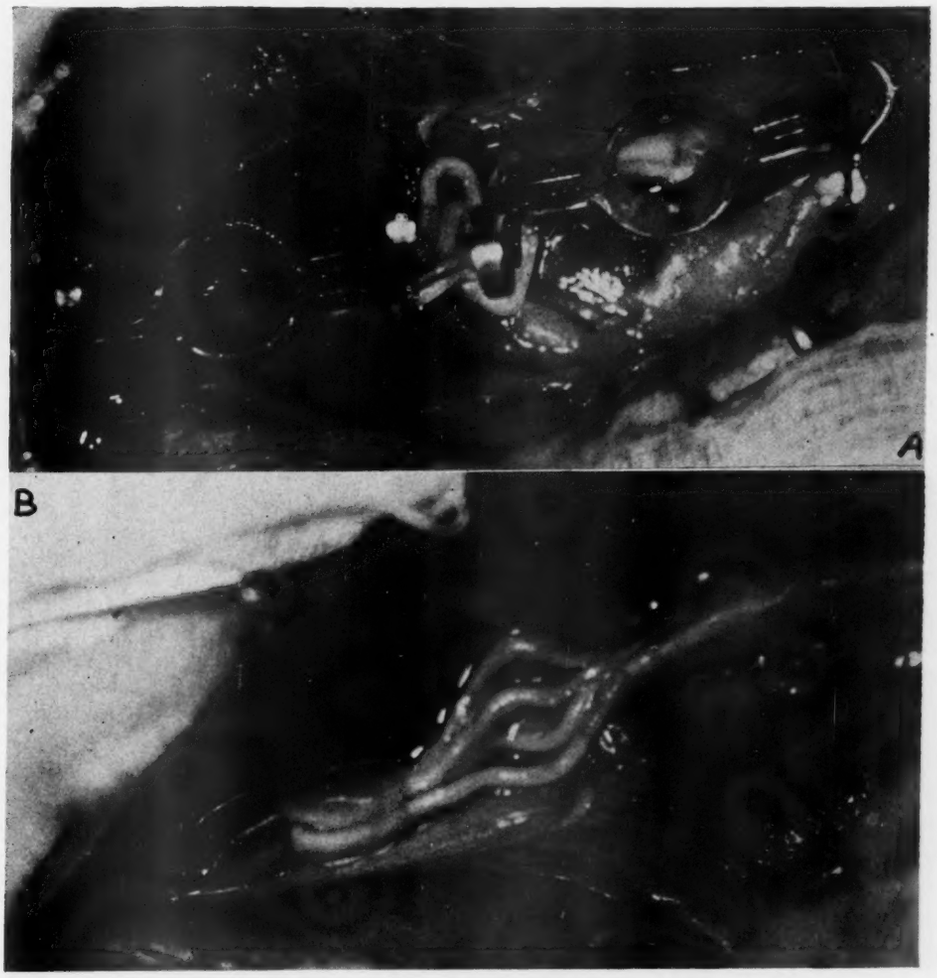

Fig. 5. The method of suturing the cable graft to the host stumps is shown. The ends of the cable and host nerve are accurately apposed on the wire rails of the latex molds and autologous unmodified plasma is added (A). After clotting has occurred the wire rails and clips of the molds are withdrawn and the molds removed leaving the suture sites surrounded by plasma clot (B). The middle segments of the cable graft have been separated in the tissue bed so as to allow vascularization of the individual strands to occur more readily. The graft must be long enough to permit spreading of the filaments in its bed. Since there is no tension on the suture site the use of tension sutures is unnecessary. The use of tantalum foil or any other impermeable membrane to surround the graft is absolutely contraindicated since blood vessels are thereby prevented from entering the graft and the occurrence of necrosis is favored.[13] The above two photographs were taken at operation on the sciatic nerve of a dog.

supplies a portion of the dorsal surface of the foot with sensation, the loss of which may be a real annoyance to an individual. For this reason, it is well to avoid use of this nerve for grafting unless the necessary supply of nerves from other sources is exhausted.

A long, though variable length (approximately 40 cm.) of the saphenous nerve may be obtained for grafting. It is rather small (1 mm. or less in caliber) and branches considerably as it courses through the leg, although a long segment of fairly thick nerve (2 mm.) may be obtained in the thigh where it is unbranched. The nerve may be exposed by an incision extending from the internal malleolus along the medial border of the tibia where it lies close in relation to the saphenous vein. It may then be followed upwards through Hunter's canal although removal of the nerve in the thigh requires a rather extensive dissection when this technic is utilized.

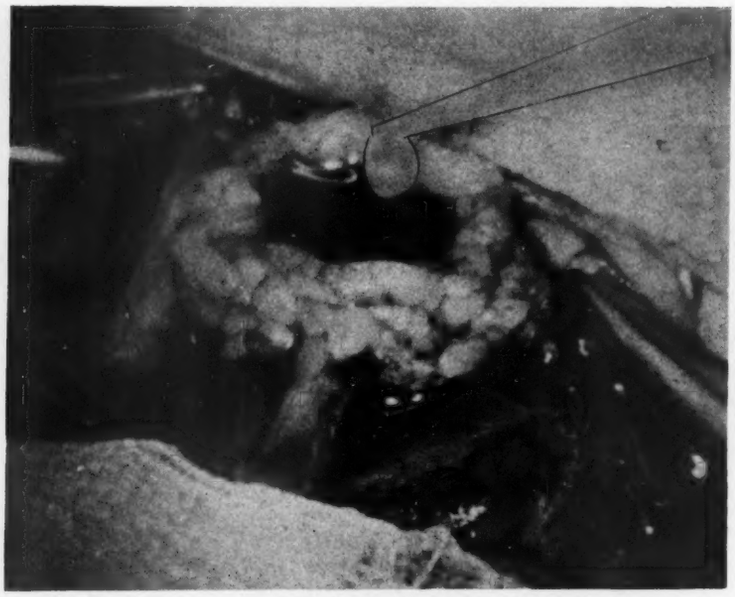

FIG. 6. Plasma clot suture can be carried out without the latex mold by building a wall around the nerve ends utilizing pieces of fat or subcutaneous tissue for this purpose. The stump of the nerve and graft are placed on pieces of tissue so that the lower surface of the suture site can be covered with plasma as well as the upper. After the plasma has clotted and the nerve suture completed, the wall should be dismantled by carefully separating the clot from it and discarding the blocks. This method is useful when, because of the lack of space or for some other reason, the latex mold cannot be used. The mold, formed of fat, should be oval in shape, in the style of the latex mold. It appears foreshortened because of the angle at which the photograph was taken at operation upon a patient.

Among the nerves of the upper extremity there are two which lend themselves for use as grafts, the lateral and medial antibrachial cutaneous nerves. The lateral (C_5, C6, C7) which represents the terminal branch of the musculocutaneous nerve, measures about 2 mm. in diameter and may be exposed by a longitudinal incision just lateral to the tendon of the biceps brachii muscle about 2 to 3 cm. above the crease of the elbow. The incision may be extended distally in a straight line to the styloid process of the radius. The nerve emerges from beneath the lateral border of the tendon and courses underneath the cephalic vein. It may be followed upwards to the middle of the arm where it lies between the biceps brachii and the brachialis muscles which receive their innervating branches above this point. Downwards the nerve may be traced into the forearm. The nerve is obtainable for a distance of 25 cm. The loss of sensation following excision of the nerve is of little concern to the patient.

The medial antibrachial cutaneous nerve (C8, T1), although close to the large vessels on the medial surface of the arm, may be quite easily exposed by an incision along the course of the brachial artery in the upper third of the arm. It lies superficial to the brachial vessels underneath the deep fascia. It may be obtained throughout its course in the arm where it measures 2 to 3 mm. in diameter. The median nerve lies lateral and anterior to it and the ulnar nerve occupies a position posterior to the brachial artery. A segment of nerve, 20 cm. or more in length, may be obtained in the arm. The nerve divides in the lower third of the arm into two branches which pass over the medial epicondyle. An additional stretch of 15 to 20 cm. of each branch of the nerve may be obtained in the forearm. It supplies sensation to the medial aspect of the forearm as far as

the wrist. The anesthesia following its excision is of little annoyance to the patient.

Knowing the diameters and the available lengths of the various nerves chosen as grafts, one can calculate roughly the length of cutaneous or intercostal nerve necessary to fill defects in various major nerves, the approximate calibers of which are shown in Table 1:

TABLE 1
AVERAGE DIAMETERS OF MAJOR NERVES OF EXTREMITIES

	Mm.
Sciatic (mid-thigh)	8.3
Tibial (popliteal fossa)	4.7
Common peroneal (popliteal fossa)	3.6
Posterior tibial (ankle)	3.5
Femoral (Poupart's ligament)	4.8
Median (origin)	4.1
Radial (origin)	4.3
Ulnar (origin)	3.8
Median (wrist)	3.5
Ulnar (wrist)	2.5

The cross-sectional areas of nerves (considered as true cylinders for the purpose of our calculation) vary according to the squares of their diameters. Thus the cross-sectional area of a nerve 4 mm. in diameter is four times that of a nerve 2 mm. in diameter so that four strips of the latter nerve would be required to fill a gap in the former. Let us assume, for example, that a 7 cm. gap in the median nerve just above the wrist is to be repaired and that one chooses the intercostal nerves for grafting. The median nerve at the level of the wrist averages 3.5 mm. and the intercostals 1.5 mm. in diameter so that squaring these figures the ratio becomes 12.3:2.3. In other words six strips of intercostal nerve would be required to repair the gap in the median nerve. It would be possible to obtain a segment of one intercostal nerve long enough to provide two strips of graft. Three intercostal nerves would therefore have to be obtained although other nerves, possibly thicker ones, such as the median antibrachial cutaneous nerve, could be chosen in which case fewer strips would be required. It is advisable to allow an extra centimeter or two in length for the cable graft in order to avoid any tension on the suture line and to allow for spreading of the strands in the tissue bed so that vascularization may more readily occur.[13]

The method of forming cable grafts and uniting them to the host stumps is illustrated in Figures 4 and 5. The use of the plasma clot technic is virtually essential for the suture of the cable grafts since thread suture of the graft results in great damage to the nerves and less satisfactory union. If the nerves to be used for the cable graft vary somewhat in thickness at their ends, the polarity of some of the strands may be reversed in order to equalize the two ends. The polarity of a graft has no effect upon regeneration that occurs through it. If the distal stump of the nerve is appreciably smaller than the proximal one, the variation in caliber of the component nerves of the cable may be utilized to form a graft that fits properly with the stumps of nerve at both ends.

When using a graft to repair a nerve gap the thought occurs as to whether one should attempt to shorten the gap by flexing the neighboring joints in order to reduce the amount of necessary graft. It is true that the longer the graft the more likelihood there is of its necrosis and fibrosis with consequent greater hindrance to the down-growth of nerve fibers. On the other hand, the subsequent extension of a limb which has been very sharply flexed in order to perform end-to-end suture of a severed nerve may result in considerable damage to that nerve.[5,6] However, satisfactory functional regeneration does occur when nerves are sutured with joints moderately flexed. We have adopted a compromise measure for the time being in view of the lack of data bearing on this point. It is recommended that grafts should be introduced into defects with joints only slightly flexed (10° to 20°) and kept in this position for a period of three weeks before extension is allowed. Further experience with the results of grafts in humans may alter this viewpoint. A

three-week period of immobilization is chosen because recent experiments of one of us (I. M. T.) as yet unpublished, have shown that in rabbits the sciatic nerve sutured with autologous plasma clot achieves a tensile strength value equal to that of the intact nerve within this period of time. It is unlikely that any very appreciable difference in this time interval of nerve healing occurs in humans. It is to be understood of course that the bed for a nerve graft should be well vascularized and relatively free from scar tissue, an ideal, however, which is unfortunately often unobtainable in practice.

The results following the use of nerve grafts cannot be expected to equal those of end-to-end suture of nerves under favorable circumstances. But in spite of the uncertainity of the results, the use of grafts is justifiable when end-to-end suture of nerves cannot be done. Reconstructive orthopedic operations may be considered if nerve grafting results in failure. When the use of a graft is found to be necessary, the operation should not be delayed inasmuch as shrinkage of the Schwannian tubes that occurs in a peripheral stump that has been left uninnervated for a long period of time may restrict the increase in nerve fiber diameter and thereby impair the functional result even though the correct connections are re-established and the muscle kept in fairly good condition.

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THE LOCAL USE OF ICE AFTER ORTHOPEDIC PROCEDURES*

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IT is the purpose of this paper to point out the benefits of locally applied cold in orthopedic surgery. Ice takes up heat rapidly from its surroundings. When the local temperature of a part is reduced, the tissue metabolism is decreased, the local blood supply is diminished and sensory end organs are dulled.

According to Jensen,[1] the range of temperature in storage ice destructive for certain bacteria is from −2°C. to −5°C. (28.4°F. to 23°F.). This range of temperature is considered to be germicidal for some bacteria. At lower temperatures, down to that of liquid air, bacteria like the typhoid bacillus remain viable nineteen months or longer. According to Baldyreva,[2] the temperature of natural ice varies between 0°C and −5°C. (32°F, and 23°F).

Fay and Henny[3] in their monograph demonstrated the benefits of local ice application for the relief of pain in metastatic carcinoma. They pointed out that this method of refrigeration when applied to the area of metastatic involvement brought about prompt relief of pain as well as temporary improvement in the general nutrition of the patient.

Krieg[4] has used ice postoperatively on the breast, abdomen and neck, and states that the temperature induced by the application of ice caps is 6°C. (42°F.). In Krieg's opinion his patients had less postoperative discomfort, required fewer narcotics and had fewer postoperative complications when ice packs were used.

Allen's[5] experimental work in the use of ice indicates that reduction in local temperature in the ligated legs of rats reduces the danger as regards both gangrene and shock. He states that in the rat "whenever the temperature can be efficiently maintained at 2°C. the limbs can survive asphyxia for a long period, the maximum of which has not been established but which is certainly more than fifty hours." In a later paper[6] he points out that "If an operation, shockless in itself, has left damaged tissues which may set up postoperative shock, this danger can be bridged by temperature control. Shock production by tissues is inhibited in proportion as their temperature is reduced." When threatening signs of loss of vitality in skin or other tissues appear, the blood supply cannot be increased effectively, but the metabolism can be cut down by reducing the local temperature, which in turn decreases the demand for oxygen and nutrition. Allen mentions that healing in the presence of ice is adequate and firm and that the danger of thrombosis is minimized.

EXPERIMENTAL

In order to determine the fall of temperature inside a plaster cast when ice is applied to the outside, leg and arm cylinders of varied thicknesses were prepared of plaster of paris rolls and sheet cotton. In each case the casts were removed in fifteen minutes, fitted together and held with an additional layer of plaster. A Fahrenheit thermometer was placed inside the empty cylinder and the cylinder ends plugged with gauze. Two covered ice bags were then wrapped on the cylinders and held in place with bandage. It was found repeatedly that within two hours the temperature inside the cast dropped to 40°F., and within three hours after the application of the ice caps to 33°F.

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By refilling the ice bags every seven hours the temperature inside the empty cylinder could be maintained at from 32°F. to 34°F.

TABLE I
SURGICAL PROCEDURES AND PLASTER CASTS

Type of Surgery	Cases with Ice			Cases without Ice		
	No. of Cases	No. of Casts Applied	No. of Casts Split	No. of Cases	No. of Casts Applied	No. of Casts Split
Knee surgery	66	30	2	82	39	24
Wrist fusions	2	2	2	4	4	4
Foot surgery	43	30	3	51	36	23
Hip surgery	28	13	0	25	6	0
Fractures	57	57	2	72	72	35
Tendon surgery	18	17	0	58	58	10
Shoulder surgery	8	2	0	6	1	0
Bone grafts	20	20	1	6	6	4
Tumors	28	6	0	60	19	4
Sequestrectomies and saucerizations	25	10	1	67	42	17
Osteotomies	12	12	0	22	22	11
Manipulations	24	0	0	4	0	0
Nerve surgery	8	7	0	7	7	0
Elbow fusions	1	1	0	0	0	0
Amputations	6	0	0	15	0	0
Totals	345	207	11	479	312	132
Percentage of casts split			5.31%			42.3%

By placing a thermometer beneath soft bandage dressings, directly upon the skin of patients on whom ice was used postoperatively it was found that the temperature dropped to 44°F. within two hours and to 41°F. within four hours. The temperature could be maintained at 41°F. therafter if the ice caps were refilled every six hours. In an extremity sheet cotton and plaster cast a thermometer when placed next to the skin was found to remain at 41°F. if covered ice bags were wrapped snugly onto the cast and refilled every six hours. The temperature at the hip or shoulder beneath a plaster spica could not be held lower than 50°F. The method has not been used in the postoperative care of spine fusion cases.

METHOD OF APPLICATION

Immediately postoperatively the cloth covered ice bags are applied directly to the plaster or soft bandage over the operative site. A sufficient number of ice caps should be used to surround the extremity completely at the operative site. When used on the extremity the bags can be held in place by elastic bandages. On the hip or shoulder cases scultetus binders may be used. The ice caps are refilled every four hours and are used for forty-eight hours postoperatively. The accumulated air in the ice caps should be released at hourly intervals to allow them to hug the cast snugly.

TABLE II
WHITE BLOOD CELL COUNTS DURING THE FIRST SEVENTY-TWO HOURS AFTER OPERATION

White Blood Cell Count	No. of Patients with Elevations					
	First Postoperative Day		Second Postoperative Day		Third Postoperative Day	
	Ice	No Ice	Ice	No Ice	Ice	No Ice
10,000 to 15,000	42	140	9	40	4	21
15,000 to 20,000	1	15	2	17	1	5
Over 20,000	0	5	0	2	0	1
Total over 10,000	43	160	11	59	5	27
Percentage over 10,000	12.4%	33.4%	3.18%	12.3%	1.4%	5.6%

RESULTS

Eight hundred twenty-four consecutive cases have been studied. Following surgery or manipulation ice caps were used on 345 patients; ice was not used on 479 patients. Table I list the types of procedures included in this series. In those patients on whom ice was used postoperatively 207 plaster casts were applied. Eleven (5.31 per cent) of these casts had to be split because of pain, swelling or other signs of circulatory embarrassment. All eleven casts were split within the first seventy-two hours. In contrast, of the 312 casts applied when no ice was used, 132 (42.3 per cent) had to be split within seventy-two hours.

Of the patients treated with ice on whom postoperative white blood cell counts were done, 12.4 per cent showed white blood cell counts of over 10,000 on the first postoperative day, 3.18 per cent on the second postoperative day and 1.4 per cent on the

third day. Of the patients not treated with ice on whom postoperative white blood cell counts were done, 33.4 per cent showed white blood cell counts of over 10,000 on the first postoperative day, 12.3 per cent on the second postoperative day and 5.64 per cent on the third day.

TABLE III
TEMPERATURE, PULSE AND RESPIRATION DURING THE FIRST SEVENTY-TWO HOURS AFTER OPERATION

Elevation	Ice		No Ice	
	No. of Cases	Percentage Elevation	No. of Cases	Percentage Elevation
Temperature higher than 38.3°C.	39	11.3	111	23.18
Pulse rate over 115 per minute	39	11.3	120	25.05
Respiratory rate greater than 20 per minute	9	2.6	70	14.6

The postoperative temperature, pulse and respiration have remained nearer normal in those patients on whom ice was used. In the group in which ice was not used, 111 (23.1 per cent) patients had temperature elevations of 38.3°C. (101°F.) or over for the first seventy-two hours postoperatively. Of the 345 cases in which ice was used, thirty-nine (11.3 per cent) had a temperature elevation over 38.3°C. for the immediate seventy-two hours postoperatively. A pulse rate of over 115 per minute for at least three postoperative days was noted in 120 (25.0 per cent) patients out of the group in which cooling was not used. When ice was used, thirty-nine (11.3 per cent) cases showed a pulse rate over 115 per minute in the seventy-two-hour period after surgery. The respiratory rate was found to run higher than 20 per minute for seventy (14.6 per cent) patients where ice was not used. When ice was used, nine (2.6 per cent) cases had a respiratory rate of over 20 for the first three postoperative days.

When no ice was used postoperatively sixty (12.5 per cent) patients developed complications such as ileus, circulatory embarrassment, thrombophlebitis, etc., severe enough to warrant special attention. When ice was used, nineteen (5.5 per cent) patients developed complications severe enough to demand special attention.

TABLE IV
POSTOPERATIVE COMPLICATIONS

Complication	No. of Cases	
	Ice	No Ice
Gangrene	1	2
Wound slough	0	2
Gastrointestinal upset	4	17
Paralytic ileus	11	12
Wound break down	3	9
Hematoma or hemarthrosis	0	16
Thrombophlebitis	0	2
Total	19	60
Percentage	5.5%	12.5%

A survey of the average of total amount of narcotic used by each patient for the seventy-two hour period following surgery is given in Table v. The figures were arrived at as follows: the type and amount of narcotic taken by each patient during the postoperative period and the quantity used by all patients having a similar type of surgery was computed. This latter amount was then divided by the total number of patients in each category.

A subjective factor was repeatedly demonstrated by the patients who received local applications of ice to the operative site. Voluntary comments concerning the relative comfort when ice was used about the operative site were gratifying. When ice was discontinued after the first forty-eight-hour postoperative period, frequently the patient asked that it be replaced because of the relief of pain which it afforded. The patient upon whom ice was used rested more comfortably, took fluids with greater ease and demonstrated a normal appetite

TABLE V

AVERAGE* OF TOTAL AMOUNT OF NARCOTICS REQUIRED DURING THE FIRST SEVENTY-TWO HOURS AFTER OPERATION

Type of Surgery	Cases with Ice				Cases without Ice			
	Codeine mgm.	Morphine mgm.	Demerol mgm.	Pantopon mgm.	Codeine mgm.	Morphine mgm.	Demerol mgm.	Pantopon mgm.
Knee surgery	76.5	8.5	6.0	2.8	256.0	36.4		
Wrist fusions	360.0	15.0			610.5	30.0	100.0	
Foot surgery	70.4	14.0	20.0		260.0	28.4	19.6	
Hip surgery	70.7	18.4			240.6	62.6	26.5	
Fractures	48.6	5.4			204.0	23.4		
Tendon surgery	30.3	6.8	3.1	1.2	249.3	9.2	16.4	
Shoulder surgery	360.5	5.0			406.0	30.5		
Bone grafts	98.0	15.1	2.8		515.3	15.0		
Tumors	49.7	2.3	5.3	.001	162.4	18.3		
Sequestrectomies and saucerizations	72.0	10.1			195.0	15.1	6.0	
Osteotomies	41.3	1.0	7.7		250.5	26.0		
Manipulations	27.0				115.0	6.0		
Nerve surgery	13.1	1.5	12.5		75.7			
Elbow surgery		60.0						
Amputations	20.0	13.9			219.0	50.8		
Average per case	89.2	11.8	3.8	.26	268.5	25.1	12.0	
Average dosage in grains per case	1.4	1.9	.06	.004	4.2	.4	.19	

* The figures were arrived at as follows: The type and amount of narcotic taken by each patient during the postoperative period, and the quantity used by all patients having a similar type of surgery was computed. This latter amount was then divided by the total number of patients in each category. As a rule, codeine was given in doses of 60 mg., morphine 12 mg., demerol 50 mg. and pantopon 15 mg.

sooner following surgery than when no ice was used. The entire convalescent period of all patients on whom ice has been used has been satisfactory.

CONCLUSIONS

The skin temperature beneath soft dressings or under padded plaster casts can be reduced by the local application of covered ice bags.

On 345 patients when ice was used locally: in the seventy-two-hour period following surgery fewer casts were split; the temperature, pulse and respiration were lower; white blood cell counts were nearer normal; postoperative complications were fewer; and the amount of narcotic per patient was reduced.

Subjectively, the patients who have ice applied locally fare better in all respects than the patients who have no ice application during the postoperative period.

The postoperative use of ice applied locally to the operative site is a valuable adjunct in the treatment of surgical patients.

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TRANSSCROTAL ORCHIDOPEXY IN ADULTS

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SOME degree of failure of descent of one or both testes occurs in 3 per cent of all males according to Strauss.[1] These abnormalities are common because, in the opinion of Moore and Tapper[2] the gubernaculum testis is liable to erratic fixation to the pubic arch, scrotal wall, or inguinal ligaments so that proper traction and descent of the testis into its normal position is prevented. Once the descent is arrested the cremaster muscles hypertrophy. This, along with bands of adhesions about the shortened cord, fixes the testis within the inguinal canal.

Since practically all undescended testes co-exist with hernial defects, the fate of the orchid at the time of herniorrhaphy must be decided. Four procedures may be followed: (1) To leave the gland in the inguinal canal following hernial repair; (2) to replace the gland within the abdominal cavity; (3) to perform castration, and (4) to do orchidopexy.

Fig. 1. Skin incision with ectopic gland overriding anterior shelf of external inguinal ring.
Fig. 2. Opening of inguinal canal and freeing cord; hernia repaired.
Fig. 3. Finger dissection of empty scrotal sac.
Fig. 4. Median raphe of scrotum held and skin and Dartos fascia incised on the distal side.

Leaving the testicle in the canal after herniorrhaphy lends itself to the possibility of recurrence of herniation and may result in painful testis. These conditions occur because the gland, lying partially free in the inguinal canal between the layers of the abdominal wall, is subjected to a

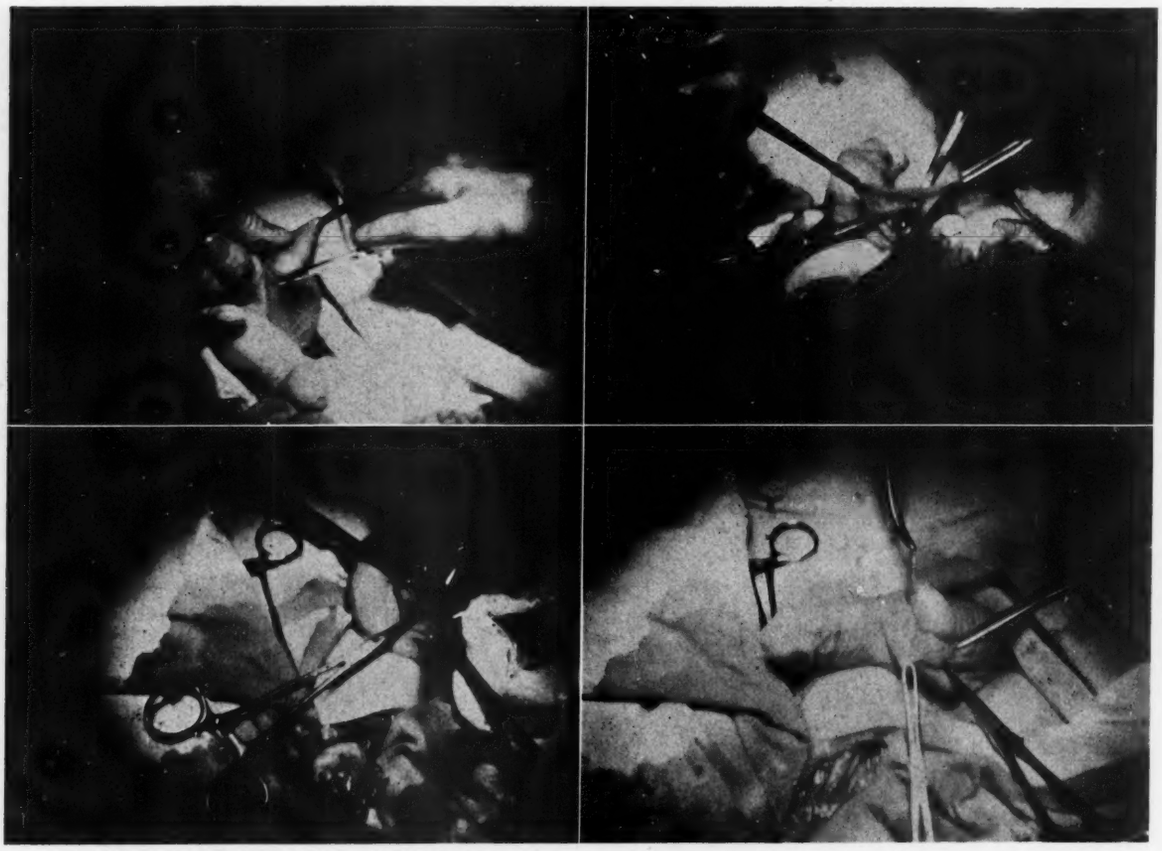

FIG. 5. Opening of mid-scrotal septum from proximal scrotal incision.
FIG. 6. Passage of a curved hemostat through scrotal fenestra.
FIG. 7. Grasping gubernaculum of testis through new canal.
FIG. 8. Transposition of testis into distal side of scrotum.

piston-like action which tends to create a reherniation of the parietal peritoneum.

Placing the gland in the abdominal cavity creates a potential source of further trouble because of continued degeneration.

Castration is a crippling procedure and should be done only if the gland is atropic or too high for surgical descent.

Fixation of the misplaced testis has, in the past, been best accomplished by the Torek[3] operation, a correction which requires several stages at intervals of from two to four months. This makes it militarily impracticable. The Bevan[4] operation attempts to fix the testis within the scrotum by partial closure of the neck of the scrotal sac. Failures frequently follow this method and are due to postoperative contraction of the cord with resultant constriction of the blood supply and atrophy of the gland.

The method of Ombredanne[5] is a possible choice; however, a search of the literature fails to show that it has ever been attempted in the adult. This means of orchidopexy utilizes the scrotal septum as the retaining point for the incompletely descended testis. In 1910, Ombredanne reported twenty-one cases of unilateral and four cases of bilateral fixations. The patients were all children ranging from six to sixteen years of age. Hagenback,[6] as late as 1943, reported eighteen such operations upon boys with good results.

Applying Ombredanne's procedure to the adult the operation is as follows: An incision is made 8 to 10 cm. in length from the pubic tubercle to the anterior superior spine parallel to Poupart's ligament. When the subcutaneous fascia is divided, the arrested testicle is usually found on the anterior shelf of the external inguinal ring. (Fig. 1.) The fascia of the external oblique is incised in a retrograde

manner to conserve the ilio-inguinal nerve and the external ring is carefully divided. This exposes the contents of the inguinal canal. The gubernaculum is carefully separated from its attachment and adhesions to the rest of the cord are separated, freeing the entire cord from its bed. The hernial defect is identified and the sac isolated and removed at its highest point to give the maximum length to the shortened cord. Retroperitoneal blunt dissection of the cord as it emerges from the abdominal cavity gives additional mobility. If further lengthening is required, the infundibuliform fascia covering the cord can be opened and the cremasteric muscles removed. In addition partial separation of the pampiniform plexus from the remaining cord structures may also be done. (Fig. 2.) Repair of the hernial defect is then accomplished, first strengthening the floor of the canal by reduplicating the transversalis fascia and utilizing the conjoined tendon which is approximated to the shelving portion of Poupart's ligament, care being taken to form the new internal inguinal ring. The fibers of the external oblique are next split at right angles and imbricated above and below the new internal ring in such a manner that the cord emerges at a greater angle from the abdominal cavity. This prevents acute angulation when healing takes place. When the repair has been accomplished and the length of the cord found adequate, the inguinal wound is temporarily abandoned and the scrotum prepared for the reception of the testis. The index finger is passed down the empty scrotal neck and the proximal sac opened by finger dissection. (Fig. 3.) Two Allis clamps are then placed on the median raphe of the anterior surface of the scrotum and a lateral incision one inch in length is made parallel to the raphe on the distal side. (Fig. 4.) This incision is carried through the scrotal skin and dartos fascia after which a space is made alongside the normal testis to accommodate the other. The finger within the empty scrotal sac is pushed against the

FIG. 9. Repair of scrotum and inguinal incisions.
FIG. 10. Left orchidopexy three months postoperatively.

scrotal septum which emerges through the scrotal incision. The septum is incised and widened to permit the passage of the ectopic gland. (Fig. 5.) A non-absorbable suture is placed at each end of the septal incision to narrow the opening pfter the testis has been delivered. At this aoint, a large curved Kelly forceps (Fig. 6) is passed through the septal fenestrum, up through the empty scrotal sac, and the gubernaculum of the mobile testis is caught. (Fig. 7.) By gentle traction the testis and cord are gradually drawn downward until the testicle emerges through the septal incision into the scrotal wound. (Fig. 8.) The sutures in the septum are then tied snugly about the cord so that the gland cannot retract and the orchid is placed in the scrotum beside the normal one. Dartos fascia and skin are closed in separate layers.

Except in the septal closure, catgut sutures are used throughout. (Fig. 9.) The remaining hernial wound is closed in layers and a dry dressing applied. Scrotal support is advised.

The septum should be opened in the most caudal position consistent with the length of the cord. When a congenital hernia is present and the testis is in the hernial sac, it is best to do a bottle-type of operation rather than a radical one because of the lessened possibility of postoperative hemorrhage. Drainage is not advisable in transcrotal orchidopexy. Figure 10 shows a right orchidopexy three months postoperatively.

Unlike the Torek operation postoperative traction in these cases in flexible because of the elastic pull and tenting of the scrotal septum. Ischemia is less likely to result. Since no fixation sutures have been placed to restrict the movement of the testis completely, it can adjust itself more readily to the length of the cord and the available blood supply. This may explain the fact that in all but one of our cases there has been a permanent increase in the size of the transcrotal testis. In one case in which there was obvious deficient length of the dissected cord, a painful testis did result for a few months which shows the importance of obtaining adequate length at the time of operation.

We believe that if orchidopexy is to be undertaken, the aberrant testis should be from one-half to two-thirds the size of the normal testis. The comparison should be made carefully for the size of the testes vary greatly.

The Ombredanne procedure with some modification was carried out in ten cases of unilateral undescended testis and hernia in patients varying from eighteen to thirty-two years of age. Cosmetic results have been gratifying and psychic improvement was noted in all cases. An additional advantage to this method is the fact that the time required for complete healing was no greater for the combined operative hernias.

CONCLUSIONS

Transcrotal orchidopexy was performed in a small series of adults with undescended testes and hernia. In one patient an undescended testicle complicated a strangulated hernia; another patient had had an unsuccessful Torek operation prior to induction. The first of these operations was done two years ago and has, as the others, been entirely satisfactory.

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A COMPARISON OF INTRAVENOUS AMINOPHYLLIN WITH THE COMMON DRUGS IN BILIARY COLIC

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IN this paper an endeavor was made to evaluate the use of aminophyllin in biliary colic, and to secure an appreciation of the comparative value of the common drugs used in biliary colic with aminophyllin. The cases used were not selected. They were consecutive in their admission both in the emergency room and on the wards. The latter were followed from the accident room to the surgical ward, and thence to the operating theater. This latter procedure enabled us to appreciate truly the value of the compound used.

The literature is very scanty in regard to the worth of aminophyllin in the use of biliary surgery. Gladstone and Goodman[1] report eight cases in which they used it in biliary colic with extremely good results. Butoch, McGowan and Walter[2] showed in their experiments that morphine and codeine raise intrabiliary pressure, while atropine and aminophyllin decrease it. The former drugs relieve pain by action on the central nervous system, while the latter act directly on the smooth muscle. The first men to use aminophyllin orally and intravenously were Mears and Delor.[3] They use it in a few cases of biliary colic.

To evaluate the drug properly, I asked the admitting physicians of a busy city hospital to use it in biliary colic following the use of other antispasmodics and narcotics. This I thought would give us a true comparative estimate of the value of the drug.

Eleven consecutive cases were seen in the emergency room. Some of the typical histories are herein presented. The others will be briefly summarized in a following paragraph.

CASE REPORTS

CASE 1. Mrs. R. G., age forty-six, was admitted July 3, 1945, to the accident room complaining of pain in the right upper quadrant for one and half days. This pain was accompanied with nausea and vomiting and followed the ingestion of a particularly heavy meal that was well spiced. The patient stated she had been having recurrent attacks of dull, aching pain in the same region for a few years. However, this was the first time that it became so severe. The day of the onset she had been given a hypodermic by her physician. The pain at no time was ameliorated but seemed to increase the day of admission, so that at the time of admission the pain radiated to the region between her scapulae.

On examination the temperature was 99°F., respirations 20, blood pressure 128/84. The patient was a middle aged female rather obese crying in pain. The physical examination was negative except for the abdominal findings. The right upper rectus was spastic and markedly tender. No other masses were palpable.

A laboratory work-up could not be obtained until the patient would consent to be admitted. However, a presumptive diagnosis of biliary colic was made. Morphine sulfate gr. $\frac{1}{4}$, and atropine sulfate gr. $\frac{1}{150}$ were administered. When no relief was obtained in twenty minutes, aminophyllin was given intravenously. The $7\frac{1}{2}$ gr. were injected slowly. In five minutes by the clock the patient had relief of pain. This case was really remarkable in the complete alleviation of symptoms.

In September of the same year, the patient again visited the emergency room with a similar episode after eating "cold cuts." This time nitroglycerine gr. $\frac{1}{100}$ was given without relief. This was followed by erythrol tetranitrate, and after ten minutes by morphine sulfate and atropine sulfate in the usual dosage as given above. When no relief was obtained in

thirty minutes, aminophyllin was injected. In five minutes there was the same spectacular result as formerly. The patient refused hospitalization as she did before.

This case merits discussion. It is without doubt a case of recurring biliary colic which clearly shows the value of aminophylin and the rapidity of its action.

Case II. Mrs. S. G., age fifty-six, was admitted to the emergency room on the night of July 29, 1945, with the complaint of severe right quadrant pain of five hours' duration. The previous history revealed pain in the same region accompanied with flatus, belching and dyscrasia to fatty foods for the past six years. However, for the first time since the onset of her illness she had had vomiting and radiation of her pain to the right shoulder.

Examination revealed a middle aged female complaining vigorously of pain in her right abdomen. Her temperature was 99.2°F., blood pressure 148/90, and respirations of 18 per minute. The physical examination revealed the following essential findings: (1) an obese female with tenderness in right upper quadrant, (2) spasm and rigidity of the upper right rectus muscle, and (3) no masses were palpable.

A presumptive diagnosis of biliary colic was entertained and the routine procedure was started. Morphine sulfate and atropine sulfate were given in the usual dosage of $\frac{1}{4}$ and $\frac{1}{150}$ gr., respectively. When no relief was obtained in twenty minutes, aminophyllin was given intravenously with complete cessation of pain in five minutes. The patient was asked to come into the hospital which she refused.

These cases quoted are typical of the other nine cases that were analyzed. They all came into the emergency room with a typical history of biliary colic so that a medical student could recognize it. All these cases had severe pain; this pain radiated to the shoulder or to the right scapula. All had previous histories of gallbladder trouble and some volunteered this diagnosis to the admitting men. In all these cases our routine was to try weak antispasmodics first as nitroglycerine, erythrol tetranitrate and atropine. When no relief was obtained after a suitable length of time, we used central nervous system narcotics as morphine and pantapon. When the relief was still unobtainable aminophyllin was used. These cases show first that biliary colic was not relieved by the common means and that aminophyllin was far superior to the other drugs used. The rapidity of relief with no toxic symptoms is in itself worthy of report.

The following are examples of the patients seen and treated in the emergency room, followed on the ward and operated upon.

Case III. Mrs. T. J., age forty-six, was admitted May 30, 1945 to the emergency room complaining of pain in the right upper quadrant. The pain was severe, radiated to the right shoulder and was accompanied with nausea and vomiting. The patient admitted to a previous history of inability to digest fatty foods without suffering from flatus, belching and eructation. This had been present for the past eight years. There was no history of jaundice, diarrhea or previous operative intervention.

On examination an obese middle aged woman was crying in pain, vomiting bile-stained material. Her temperature was 99°F., blood pressure 140/80, respirations 18 per minute. Essential findings were spasm, rigidity of the right upper quadrant with marked tenderness. No masses were palpable.

The patient was put on our established routine for investigation of the drugs concerned. Erythrol tetranitrate was given without relief. This was followed in ten minutes with pantapon gr. $\frac{1}{2}$. With this drug there was some amelioration of symptoms but no relief. Pantapon gr. $\frac{1}{3}$ was then administered which also had no effect after the measured interval of ten minutes. At this time the patient was admitted to the hospital. Here 5 per cent glucose in saline was started. After thirty minutes, aminophyllin was given. The pain had at no time disappeared. After the administration of this drug, the alleviation of pain was complete in five minutes.

On the ward the laboratory work-up showed the urine to be negative for bile, albumin and sugar. The red count had a 4.2 million red cells, 82 per cent hemoglobin, a white count of 11,200 with 68 per cent polymorphonuclears, normal sedimentation rate, negative van den Bergh, icteric index of 10, cholesterol of 90.

The gallbladder series revealed poor function and numerous stones.

While on the ward the patient had return of her pain. In every instance the use of aminophyllin gave relief. The patient was operated upon under pontocaine anesthesia and the gallbladder was removed. It contained many stones of various shapes and sizes. From then on she made an uneventful recovery.

Case IV. Mrs. I. M., age forty-eight, was admitted March 2, 1945, through the emergency room complaining of knife-like pain in the right upper quadrant radiating to the region between the scapulae. The pain was of ten hours' duration following a meal of macaroni and spaghetti. There was a previous history of dull aching pain for the past two years with idiosyncracy to fatty foods, and marked belching and flatus. The rest of the history was essentially negative.

Examination revealed a stout Italian woman of middle age groaning in pain. Her temperature was 99.2°F., blood pressure of 142/88, respirations 20 per minute. The conjunctivae showed on icterus. The only positive findings were no examination of the abdomen. Here there was marked rigidity, spasm and tenderness of the right upper rectus. No masses could be palpated.

The patient was tried on the routine of nitroglycerine, atropine and papaverine. The latter again showed some amelioration of symptoms. When the patient still continued to complain, aminophyllin was given intravenously. The relief was immediate in seven minutes.

The patient was then brought to the ward where a work up revealed a urine negative for bile, a white blood count of 12,200 with 68 per cent polymorphonuclears, red count of 92 per cent hemoglobin and 4.8 million red cells, icteric index of 16, negative van den Bergh, normal bleeding and coagulation time, cholesterol of 110. The gallbladder series showed poor function and numerous stones.

While on the ward the patient had to be given aminophyllin at various times for the relief of pain. On March 9, 1945, seven days after admission, the patient was operated upon after suitable preparation. A gallbladder full of stones was removed.

Case V. Mrs. M. G., age fifty-four. This case is worthy of review since it points out that not every case of cholecystitis is helped by aminophylin and that morphine and atropine still have their places in our armamentarium.

The patient was admitted with the history of right upper quadrant pain of three weeks' duration. The pain was of the dull aching variety and did not radiate. This pain was never associated with vomiting and nausea. However, during this episode the pains were more severe and incapacitated her even though the history went back for three years. The remainder of the history was negative.

Examination revealed an apprehensive woman of middle age complaining of pain in her right upper quadrant. Temperature and respiration were normal. The blood pressure was 124/74. The only positive findings were in the abdomen. Here we had a positive Murphy, slight spasm and rigidity of the upper rectus.

Laboratory work showed negative urine, a normal blood count, normal bleeding, coagulation time, icteric index, van den Bergh and cholesterol. The gallbladder series showed poor function and poor emptying but no stones. The gastrointestinal series was negative.

This patient was not in distress, consequently aminophyllin was tried first. This did not relieve her aching pain in fifteen minutes. Then morphine was tried with relief. This patient was operated upon. A gallbladder without stones was removed. However, there were numerous pericholecystic adhesions around the gallbladder.

Thus we have a case in which aminophyllin had no value. This illustrates in my mind that its prime use is in colic in which there is associated spasm of the cystic or common ducts.

A résume of the other ten cases are in order. These cases had symptoms of biliary colic all with typical symptoms and findings. All these patients had relief with aminophyllin after the other common drugs had failed. All showed in varying degrees some relief with papaverine but the pain returned shortly. All were relieved within five minutes after the intravenous administration of aminophyllin. Seven and one-half gr. was the dose used in every case. Among these cases we had one of empyema associated with stones. This patient, a rather elderly male, had no relief with the other antispasmodics or with the narcotics. With aminophyllin he had moderate re-

sults. At operation he was found to have an empyema with stone formation. To explain this we must look to the pathology concerned. This patient had a severe infection with moderate amount of spasm.

CONCLUSIONS

1. Aminophyllin is the drug of choice for the relief of smooth muscle spasm associated with biliary colic.

2. A number of the patients with biliary colic treated in the emergency room were able to leave after a simple intravenous administration of aminophyllin.

3. Aminophyllin, if given slowly, does not produce any toxic symptoms.

4. Papaverine is the second choice in the alleviation of biliary colic.

5. Morphine or its derivatives are poor drugs for the relief of biliary spasm.

6. Aminophyllin has no place in the armamentarium for the relief of postoperative pain.

7. Since this work shows clearly the value of aminophyllin as an antispasmodic in biliary colic, it is suggested that the surgeon use it directly into the cystic or common ducts following the finding of stones in the gallbladder. This would cause the sediment and small stones to pass into the duodenum.

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EXTERNAL SKELETAL FIXATION OF FRACTURES

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THESE few remarks are not published with the idea of presenting anything new or original but rather to present one man's opinion of this method of treating fractures and to try to explain some of the commonly published criticisms of skeletal pinning of fractures. The treatment of any fracture should be based upon the three cardinal principles of fracture therapy, namely, (1) restoration of all fracture fragments to their true anatomic position, (2) maintenance of that true anatomic position until satisfactory union has occurred, and (3) the preservation of all possible function of joints adjacent to the fracture while it is immobilized.

Restoration of anatomic position of fragments is brought about in almost every instance by traction, countertraction and anatomic manipulation aided in some cases by pressure applied in areas where comminuted bone fragments are located. Traction and countertraction in many cases is difficult due to the movement of soft tissue on bony structures making it impossible to obtain a secure hold on either the distal or proximal fragment. To grasp a leg with one's bare hands to apply traction and countertraction is sometimes impossible, consequently, resulting in a poor reduction or no reduction at all.

Assuming that satisfactory traction, countertraction, manual manipulation, etc., can be accomplished in spite of the elasticity of the soft tissue and a good reduction can be obtained, it is in many instances difficult to maintain this reduction. Particularly in small hospitals where incompetent and insufficient help is employed, to immobilize a well reduced fracture with plaster of paris presents another problem. We have all reduced a fracture of the humerus, tibia, or even a simple Colles fracture under a fluoroscope and had an orderly to attempt to hold that reduction while a plaster cast was applied and later became very disheartened when we examined a final radiograph. Many fractures which are reduced are difficult to hold manually even by an experienced assistant.

The three cardinal principles of fracture therapy are much more easily accomplished in most cases if the fracture fragments can be manipulated directly and not through the medium of the surrounding soft tissue. Direct contact with the bone is satisfactorily accomplished by placing pins or screws into the bone by some of the methods described by Drs. Roger Anderson, Shaar, Haynes and others. By movement of these pins or screws, traction and other manipulation is made considerably less difficult.

There are many advantages in treating fractures by some of these methods of external fixation. It is far more easy and less hazardous after reduction has been accomplished to place that extremity on a flat table and immobilize the fracture by connecting all of the pins together than to have some inexperienced assistant to steady it for fifteen to twenty minutes while a plaster of Paris cast is applied. The immobilization of a fracture with pins and rods, if properly applied, is also more stable than a plaster of Paris cast because of the fact that a cast sooner or later becomes loose fitting.

External fixation of fractures also simplifies the surgical care of the skin and other soft tissue damage. Compound fractures are a common cause of a large area of soft tissue injury which is difficult to cope with after application of a cast. Even when a small area of soft tissue is involved by the injury and a window is removed from the

FIG. 1. Case 1. Spiral comminuted fracture of left humerus.

FIG. 2. Case 1. Anteroposterior view after reduction. Notice fracture through tuberosity of head of humerus.

cast through which the wound can be aseptically dressed, the drainage often saturates the cast giving rise to an offensive odor which is unpleasant to the patient and his or her associates and which commonly also leads to an extensive skin eruption which is uncomfortable.

Many orthopedist's answer to this would be to apply the cast and forget the soft tissue damage until the fracture is healed, but we in the country are apparently more sensitive about our body odors. When I, personally, receive such an injury I pray that my doctor will see his way clear to cleanse the exudate from my wounds daily or as often as may be necessary.

Traumatized soft parts accompanied by fractures are more easily treated and daily care is more easily carried out when skeletal-external fixation methods are applied for the treatment of the fracture. There is no offensive odor as there might be from various types of exudate pent up in a cast for several weeks. The danger of moving the fractured fragments while dressing injured soft tissue is at a minimum, thus lessening the possibility of a non-union or an impairment of good bone repair.

Regardless of the simplicity of immobilization of any fracture of an extremity, some joint, either a wrist, elbow, ankle, or knee, etc., is almost invariably immobilized as well as the fragments themselves. This immobilization of joints for several weeks often times gives rise to stiff joints which in many instances results in more latent grief than the fracture itself. This is particularly true in smaller communities such as the one in which I am located because of the fact that various types of physiotherapy and massage are sadly neglected. The use of external fixation brings to a minimum the number of stiff joints to be placed in the doctor's field of vision at a later date, possibly on some occasion in society where

embarrassment might be brought to bear. This method of treatment of fractures makes possible to some extent the use of what physiotherapy that might be available during the period of immobilization.

We constantly hear and read in the literature of men of renown who criticize skeletal fixation and tell of its horrors and disadvantages. Naturally, as is the case of any method of treatment of anything, there are some disadvantages and poor results but for the most part these disadvantages and poor results are avoidable because the method is mistreated or altered to suit an individual's taste. For instance, the most common criticism placed before the medical profession is the statement that the drilling of pins into a bone gives rise to a portal of entry for infection. On the surface this certainly would seem likely but I have yet to see an infection actually involving bone from the insertion of a stainless steel pin or wire provided it was correctly placed. I have seen many pins which were incorrectly placed about a fracture that was the source of considerable skin and other soft tissue necrosis which gave rise to a large amount of serous drainage. But still in these cases I have not seen infection truly enter bone nor have I seen a case of pressure necrosis around a pin which did not heal in seventy-two hours after the pin was removed.

Fig. 3. Semi-lateral view of Case 1 after reduction.

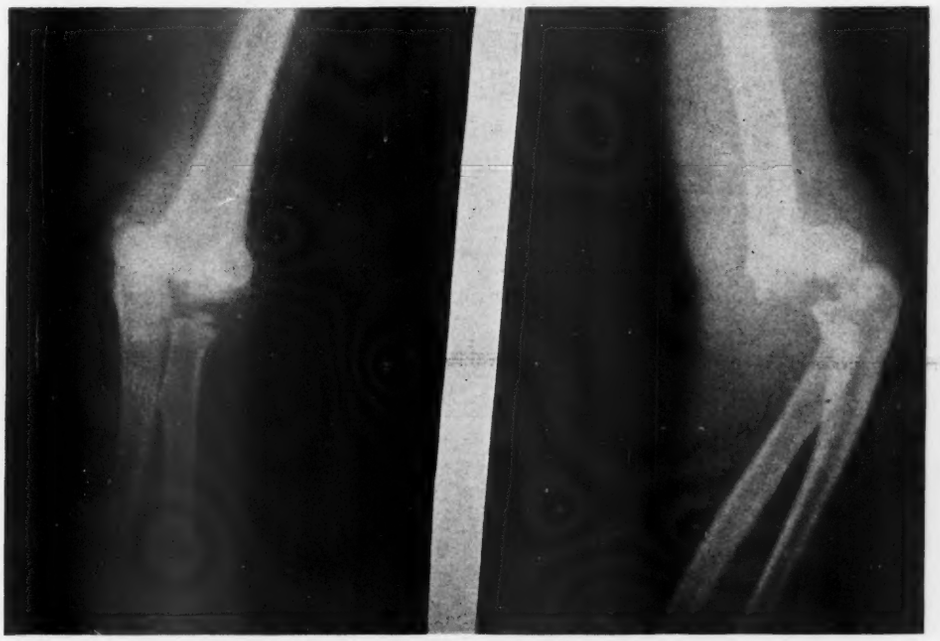

Fig. 4. A supracondylar fracture of left humerus in anteroposterior and lateral views described in Case 11.

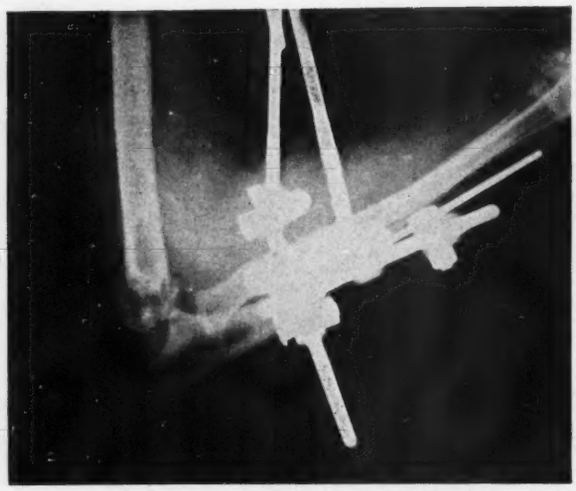

FIG. 5. Lateral view of Case II three weeks after reduction. Anteroposterior view is not shown due to poor detail of radiograph making a photograph impossible.

Placing pins for the external fixation of fractures is like any other surgical procedure, there are a number of "tricks" about it which a surgeon must learn either from his colleagues or from sad experiences if good results are obtained. The pins must be placed in specific locations usually near the ends of the long bones regardless of the type of fracture one might be treating. This is what has been described as "precision pinning." Pins are more often placed as near the ends of long bones as possible because here the blood supply is greater and because this usually makes more leverage possible for manipulation and immobilization of the fracture.

Pins must be placed through the soft tissue in a line direct from the point of entrance into the skin to the point of entrance into the cortex of the bone into which the pin is to be placed. In other words, when a pin is placed through the skin and other soft tissue, it must be pushed in a direct line to the bone and not pulled up or down or anterior or posterior before entering the cortex. Such a procedure is the etiology of most of the soft tissue necrosis we see. I have seen instances in which nature would gradually lessen the tension of skin against a pin by a process of advancing necrosis which would completely heal tightly around the pin when the skin had traveled far enough to remove all the tension or pull against it and then the drainage would cease. This slow process gives rise to pain until all the pressure has been removed.

FIG. 6. Compound, comminuted fracture of right radius described in Case III before reduction.

When placing pins into a bone, it is necessary to make allowance for the amount of traction to be applied later to accomplish the reduction of the fracture.

Fig. 7. Lateral and anteroposterior views of Case III after reduction. The poor reduction is probably responsible for the 50 per cent limitation of suppination.

Let us take for example a fracture of the mid-shaft of the femur in which there is possibly two or three inches or more overriding of fragments. In such a case, if pins are placed directly above and below the fracture and then enough traction is applied to pull the lower fragment down the necessary two or three inches, the skin between the pins will be under great tension and give rise to severe pain. This can be overcome by placing the pin through the soft tissue to the bone and sliding the pin down over the periosteum for two or three inches toward the fracture before entering the cortex of bone. When this is done there will be no soft tissue under strain and tension after the reduction is accomplished. If this procedure is not carried out, it is better after the reduction to place a sharp pointed knife down along the pin and split the tense skin until all the tension has been overcome. This small cut will usually heal snugly around the pin within a few days.

Another common criticism that we hear is that the pins "work loose" in the bone due to bone necrosis. This is true many times of a through-and-through pin but is rarely true of a half pin if it is drilled into the bone properly. I have noticed that when removing pins after an adequate period of immobilization that many times a through-and-through pin can be removed merely with the thumb and finger but this

Fig. 8. Intertrochanteric fracture described in Case IV before reduction.

FIG. 9. Lateral view of Case IV after reduction and introduction of first pin from shaft of femur through the fracture into head.

is not true of a pin that has been placed only through both cortices of bone and has not protruded on through the skin and soft tissue of the opposite side. Naturally, if a pin becomes loose it must be due to

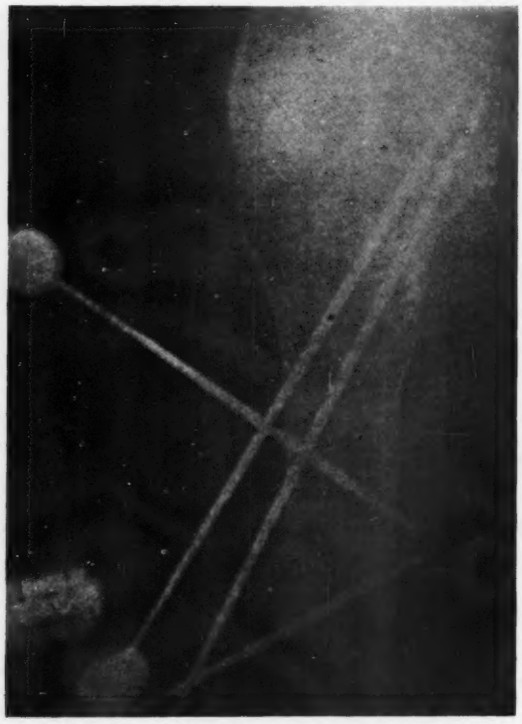

FIG. 10. Anteroposterior view of Case IV after introduction of pins through the fracture into the head of the femur and the half pin unit below the fracture site.

necrosis of bone and this is usually due to an improper method by which the pin is placed into the bone. When a pin is placed into a bone with a hand chuck at a low rate of speed it will remain tight in that bone for an infinite amount of time. But if a highly geared drill is used and the pin is turned at a rapid rate of speed, a thermal necrosis will be caused resulting in a loose pin at a later date.

Electrolysis has been said to be an etiological factor to "loose pins" but this has never been proven to my own satisfaction. Electrolysis is said to be a process by which a metal is decomposed by a current flowing between two different metals through a salt solution. In the first place, there is only one type of metal involved and, secondly, I have never seen a stainless steel pin removed from a bone which grossly demonstrated any visible signs of chemical decomposition. So it is my meager opinion that electrolysis as a cause of bone necrosis is more theory than fact.

Another seemingly unimportant "trick" to this method of treatment of fractures is the application of a dressing to the pins which actually is the all important thing in the prevention of "draining pins." If the skin and soft tissue can not move around or

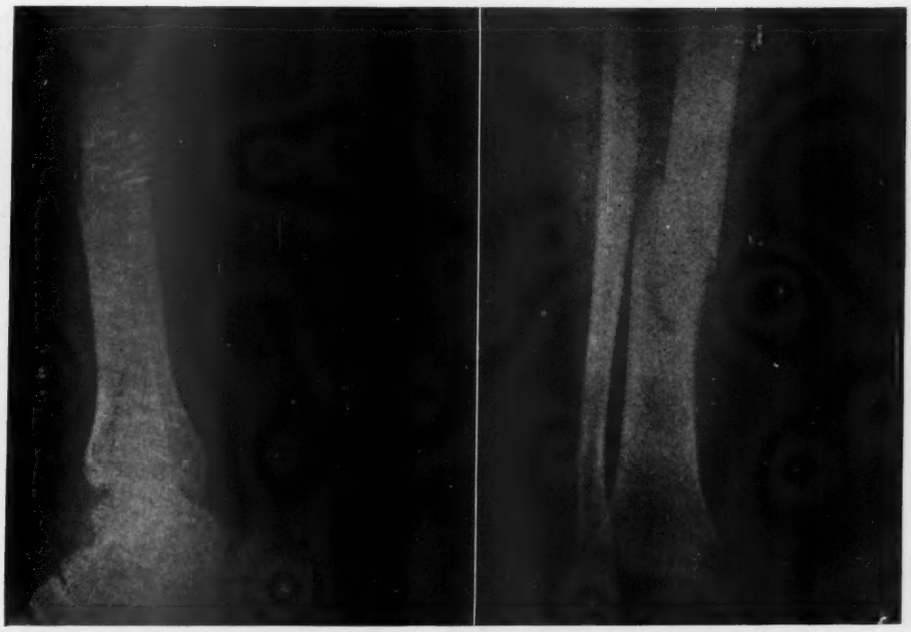

Fig. 11. Anteroposterior and lateral views of Case v; fracture of tibia in middle third and of fibula in lower third.

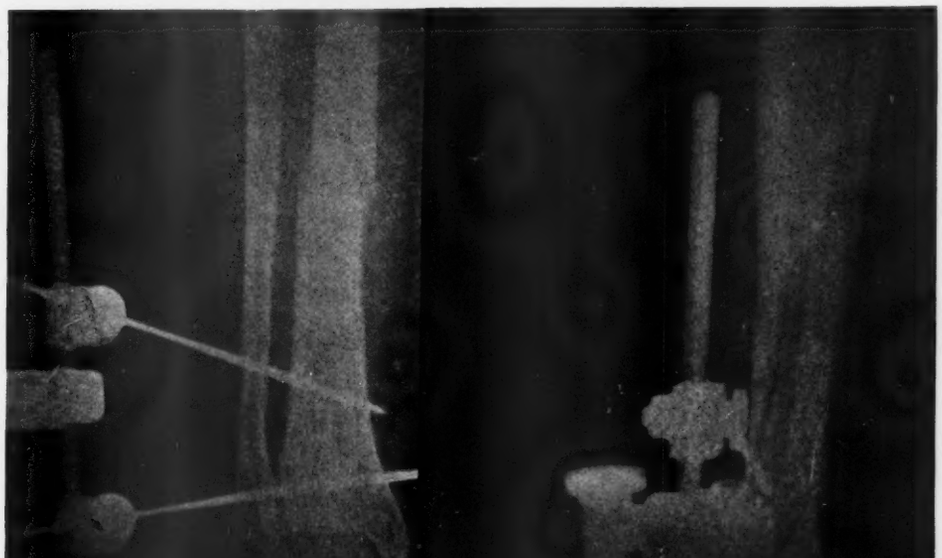

Fig. 12. Anteroposterior and lateral views of Case v after reduction.

against a pin, there will be no drainage, assuming, of course, that the technic of placing the pins into position has been aseptic. Consequently, a dressing must in some manner be placed around the pin compressing the soft tissue against the underlying bone structure. In a recent article by Dr. E. H. Wilson the statement is made that "in the femur the upper pin almost always causes pain because of the amount of motion necessary in the muscles of that region while active." This statement is perfectly true but I have found that a great percentage of "painful pins" in that region can be overcome by the use of proper pin sites and by a properly applied dressing. This is rather difficult to overcome in the extremely obese patient but a "painful pin" and drainage around that pin will assure the surgeon that there has been enough

FIG. 13. Anteroposterior and lateral views of Case VI showing compound, comminuted fracture in lower third of tibia and fibula before reduction.

active motion of the hip joint that the worry about a later stiff hip joint is nil.

Much of the criticism of this method of fracture treatment that we commonly hear has its origin from surgeons who have treated two or three fractures before they had taken the time and trouble to master the principles of the technic and this criticism is certainly unjust. The use of skeletal pinning and external fixation is a study in itself. Pins cannot be "thrown" into a bone in just any location, connected together by rods, and a good result be anticipated. I recently attended a meeting in which an Army dental surgeon highly criticized the pinning of mandible fractures because "the pins came loose and left unsightly scars on the face." In that large Army Hospital only three such cases had been treated by this method and when photographs were exhibited, it was obvious that the poor results were due to the fact that the operator had no conception whatsoever of the principles of the technic he had attempted to employ. Many men are obtaining excellent results in the treatment of mandible fractures by the proper technic.

I have commonly heard the statement "if you want non-union, use skeletal pinning." In several instances I have had an opportunity to examine the radiographs of these non-unions only to find in almost every instance the fragments had been fixed in such a manner that there was at least one-fourth to one-half an inch space between the fragments. Now any physician with any understanding of histology and pathology should realize that nature has unfortunately not yet given birth to a fibrocyte or osteoblast that could jump such a gap. As has been stated before "this technic is a method of the treatment of fractures by contaction and not by traction."

Skeletal pinning and external fixation is not the final word for treatment of every fracture and there are undoubtedly many instances in which it is used where a more simple method would suffice. But I do believe that if the principles of this technic are mastered before it is put to practice, that it will solve many of our fracture problems.

I have chosen several cases to present various types of fractures which have successfully been treated by skeletal pinning and external fixation which treated by any other method would have required longer

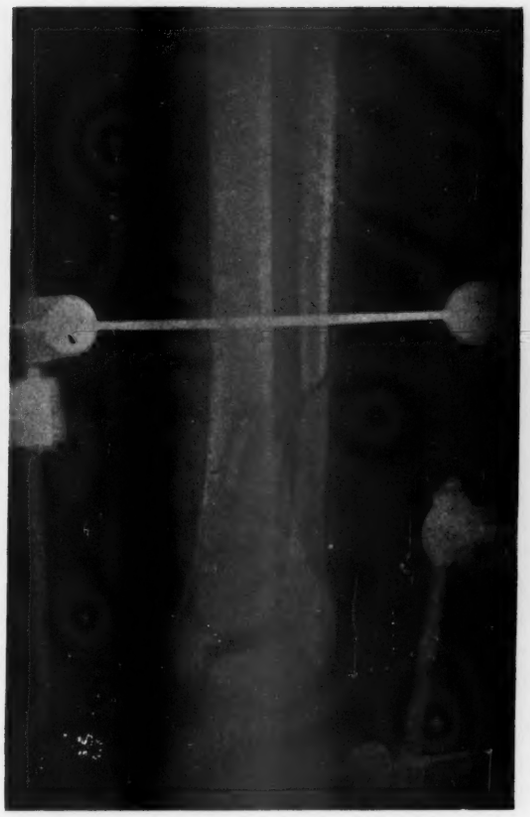

Fig. 14. Anteroposterior view of Case VI after reduction.

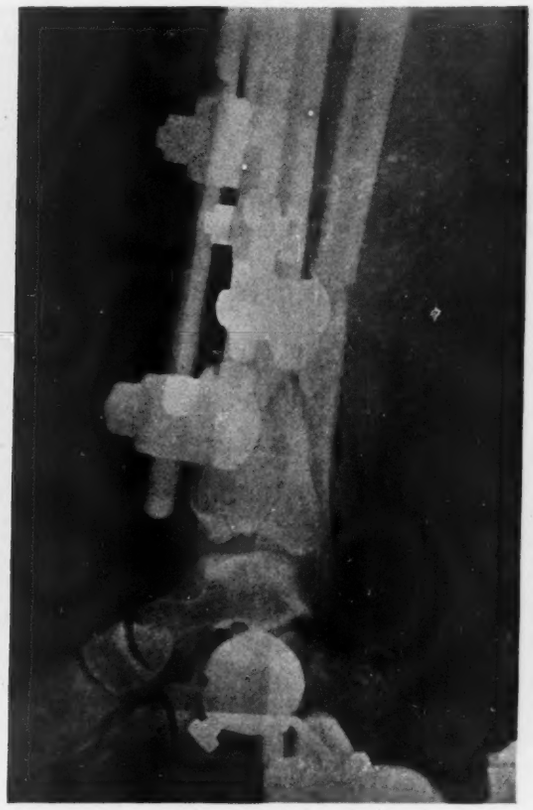

Fig. 15. Lateral view of Case VI after reduction.

periods of hospitalization or more discomfort to the patient.

Case I. A white male, age fifty-four years, fell on the ice on Christmas day, 1944, and received a spiral fracture of the upper third of the left humerus and a comminuted fracture of the head of the same humerus, as shown in Figure 1. There was considerable hemorrhage and damage to the surrounding soft tissue. Under ether anesthesia and with difficulty, two pins were placed into the comminuted head obtaining a firm hold on the upper fragment. A half pin unit was placed in the posterior surface of the distal end of the distal fragment and a satisfactory reduction obtained by a self aligning splint after which the two units were connected by a long curved rod as shown in Figures 2 and 3. This patient had considerable pain for about three weeks apparently due to hemorrhage and soft tissue damage but not at the pin sites. After this time he was able to get about 80 to 85 degrees abduction of the shoulder and almost full range flexion and extension of the elbow and was able to carry out his usual duties in a bank. On February 20, 1945, eight weeks after reduction, the equipment was removed and a good solid union was found. The patient at present has an almost normally functioning shoulder and elbow.

Case II. A white male, age seven years, fell off a porch and received a supracondylar fracture of the left elbow as shown in Figure 4. When first seen there was considerable edema of the soft tissue at the fracture site and "skin blebs" had begun to form. This would have been a poor case to place in marked flexion and immobilization in this position with plaster of Paris to run the risk of a Volkman's paralysis. A one-half pin unit was placed in the superior humerus, care being taken to avoid damage to the epiphysis. One through-and-through pin and a half pin was placed in the olecranon. The reduction shown in Figure 5 was obtained and rods connected the units both on the medial and lateral sides of the elbow fixing the elbow joint in semi-flexion. The patient had very little discomfort and it was possible to make daily observations of the skin and soft tissue near the elbow until the edema had subsided. The patient was able to play as usual and the equipment was removed during the fifth postoperative week. He has a

FIG. 16. Anteroposterior and lateral views of Case VI sixteen weeks after accident and after removal of pins and other equipment.

final result which would be considered a normal joint from the functional standpoint.

CASE III. A white male, age fifty-two years, received a compound, comminuted fracture of the right radius as a result of a dynamite explosion in a coal mine. (Fig. 6.) After cleansing the wound and carrying out a débridement, sulfanilamide powder was placed into the wound and it was closed without drainage. A half pin unit was placed through the distal radius and one through the superior radius and the reduction seen in Figure 7 was obtained. The compound wound healed by primary intention. The patient had an uneventful convalescence with the exception of the superior pin which had been improperly placed, being lateral instead of medial to the flexor carpi radialis longus muscle, which caused pain and some drainage which had subsided before the equipment was removed the seventh postoperative week. At present, eleven weeks postoperatively, the patient has an arm with 100 per cent pronation and only about 50 per cent suppination which will improve to some extent with time and use and which was due to a rather poor reduction that should have been improved upon in the beginning.

CASE IV. A white female, age seventy-one years, fell and received an intertrochanteric fracture of the right hip as shown in Figure 8 and who five years prior had received a similar fracture of the left hip which was treated by a Buck's extension with a poor result. On admission into the hospital the patient had a blood sugar of 220 mg. per 100 cc. of blood besides an auricular fibrillation. Two weeks were required to control the fibrillation and the diabetes during which time the injured leg was placed in a Thomas splint. The first day of the third week, under ether anesthesia, a reduction was obtained by aid of a fracture table. Parallel $\frac{4}{32}$ by 10 inch pins were placed from low on the shaft through the fracture into the neck and head of the femur, care being taken by a lateral radiograph that the pins were in correct position along the anterior medial cortex of the neck as shown in Figure 9. A half pin unit was placed in the shaft below the fracture and all four pins connected by two rods as shown in Figure 11. Time was spent in applying a dressing which firmly compressed the skin and soft tissue around the pin sites. The patient was in a wheel chair the second postoperative day and daily thereafter. The thigh was fully flexed on the abdomen at random. The equipment was removed the sixteenth week and a satisfactory union and good functional results obtained. During the period of immobilization the pin sites were dressed only four times and each time the pin sites were found clean with no drainage, undoubtedly in this satisfactory condition due to the pressure dressing.

CASE V. A white female, age forty-one years, fell off a ladder and received a spiral

fracture of the middle third of the left tibia and a fracture of the lower third of the left fibula as shown in Figure 11. The leg was first put in traction and a padded plaster of Paris cast was applied from the upper thigh to the toes. Three days later a radiograph taken revealed that the lower fragment was rotated and the fragments were overlapping about two inches. One through-and-through pin and a half pin was placed in the upper tibia and the same in the lower tibia. A satisfactory reduction was accomplished. The pins were connected with rods as shown in Figure 12 and the fracture was left immobilized for ten weeks. At that time a radiograph demonstrated adequate callous formation and the pins were removed and the fracture was found to be solid to manual manipulation. Weight bearing was permitted in sixteen weeks from the time of the injury. At present the patient has a normal functioning leg.

Case VI. A white female, age thirty-eight years, received a badly compound, comminuted fracture of the left ankle in an automobile accident as shown in Figure 13. There is also a fracture through the internal malleolus and the fibula similating a Pott's fracture. The soft tissue wound was débrided after the usual aseptic preparation. The protruding upper fragment was manipulated as near as possible into place and the wound was filled with sulfanilamide crystals and closed without drainage. Two through-and-through pins were placed in the upper fragment, one at the upper tibia and one just above the fracture site, and another through-and-through pin was placed in the os calcis. With the aid of a self aligning splint the fracture was satisfactorily reduced as shown in Figures 14 and 15. A posterior plaster of Paris mold was applied from the knee to the toes to act as a support to prevent any posterior displacement and also to prevent a "foot drop." The posterior cast was removed in eight weeks. There was some purulent drainage from the medial side of the pin just above the fracture which subsided in forty-eight hours after the sutured area was opened to allow adequate drainage from the infection caused by the compound fracture. This infection had subsided and drainage stopped within two weeks with the aid of chemotherapy. The pins were removed sixteen weeks following the injury and a solid union was found as shown in Figure 16. This radiograph also reveals considerable osteoporosis undoubtedly due chiefly to the infection at the fracture site. At present the patient has a good functional ankle joint although there is still some weakness probably caused by the osteoporosis. At the present, twenty-two weeks after injury, she bears full weight on the foot but wears a high top leather shoe.

There are many other fractures which are satisfactorily treated with this method.

SUMMARY

1. Skeletal pinning and external fixation has been discussed. The general principles with this method are the same as for any other method of fracture therapy and must be respected and not forgotten.

2. Some of the advantages and disadvantages of skeletal pinning and external fixation have been discussed.

3. Common criticisms have been discussed and explained.

4. Cases for various types of fractures treated by skeletal pinning and external fixation have been presented.

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CONSERVATIVE TREATMENT OF THYROTOXICOSIS WITH THIOURACIL

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FOLLOWING Astwood's[1] introduction of thiouracil in the treatment of thyrotoxicosis, numerous clinical reports appeared on this subject, dealing mostly with the preoperative employment of the drug. It seemed desirable to supplement the reported observations by a study of the usefulness of thiouracil* in situations which make a conservative treatment of hyperthyroidism the method of choice.

MATERIAL

With the kind collaboration of my colleagues at St. Elizabeth Hospital a group of twenty-one patients was selected for the study. Five of the patients had had one or more subtotal thyroidectomies and refused to undergo a second operation. Of the remaining sixteen, thyroidectomy was contraindicated in three on account of old age (over seventy-three years) accompanied by far advanced senile changes in the cardiorenal system; six had signs of heart failure caused by valvular lesions poorly responding to the customary therapy; three had coronary sclerosis; two were suffering from malignant hypertension, one had cirrhosis of the liver with recurrent ascites and one had diabetes and hypertension.

The age of the patients ranged from thirty-two to seventy-six; twenty were females and one was male. Twelve patients had a diffuse, hyperplastic type of goiter, four had a toxic adenoma and five had recurrent hyperthyroidism after operation.

Seventeen patients had had hyperthyroidism for more than two years; two patients had had signs and symptoms of thyrotoxicosis for over one year and two for over eight months.

The basal metabolic rate at the onset of treatment with thiouracil ranged from 32 to 68 with the average of 41.

Of the twenty-one patients, three had been previously treated with Lugol's solution but an interval of several months elapsed between cessation of administration of iodine and the start of thiouracil therapy.

METHOD OF TREATMENT

Two cases required hospitalization on account of concomitant diseases while in all others the thiouracil therapy was ambulatory. Patients were allowed to continue their usual activities and no special dietary régime was prescribed, the diabetic patient being the only exception. In order to obtain clear cut results of the thiouracil treatment, all other medications were avoided with exception of an occasional laxative. All patients were given a complete physical examination before the treatment was instituted. Blood counts, including the differential count, were repeated in course of the thiouracil treatment at seven to ten day-intervals and the basal metabolic rate was determined every two or three weeks.

In the early stages of the investigation the usual initial dose was 1 tablet, containing 0.2 Gm. of thiouracil, three times daily after meals. On repeated occasions the patients described certain symptoms of intolerance of the drug, such as nausea, dizziness, tremor and tachycardia. Although the symptoms were insignificant, they suggested a new mode of administration of the drug; the first three days the patients were given only one tablet after breakfast, the next three days one tablet

* Generously supplied by Eli Lilly & Co., Indianapolis, Ind.

after breakfast and lunch and after the first six days one tablet was to be taken three times a day after meals. Absence of untoward symptoms corroborated the hypothesis that a gradual increase of the total daily dose gives the organism sufficient time to develop tolerance of the drug. It must be stressed that this gradual increase of the daily dose proved beneficial as far as the avoidance of the initial symptoms of intolerance was concerned; it was unable, however, to prevent certain more serious toxic side effects.

After the dose of 0.2 Gm. three times a day had been reached, it was continued until there was a marked symptomatic improvement and the basal metabolic rate dropped to about +15, after which time the dose was reduced to 1 tablet after breakfast and supper. As soon as the basal metabolic rate reached the normal level, the dose was reduced to one tablet after breakfast only. If the rate did not show any tendency to rise, the maintenance dose was reduced after two or three weeks to one-half to one tablet once a day. In no less than eight cases out of twenty-one it was possible to further reduce the dose to one tablet on Monday, Wednesday and Friday only.

On repeated occasions it became necessary to increase the dose temporarily when the basal metabolic rate rose, usually due to an emotional strain, only to be reduced again when the rate dropped to the normal level. In other words, a continuous close observation was required to adjust the dose to the patient's requirements.

Fifteen patients had received the drug for as long as 5 months and the remaining six for a shorter period of time. If the therapy was discontinued, a relapse of the thyrotoxicosis occurred within two or three weeks. In not a single case was it possible to produce a sustained remission after cessation of the therapy.

RESULTS

Out of twenty-one patients the administration of thiouracil had to be discontinued in two soon after it was instituted on account of toxic side effects. In all others a full control of objective signs and subjective symptoms of hyperthyroidism was obtained. The basal metabolic rate showed a progressive fall until it declined to the normal level within two and half to six weeks after the treatment had begun. Gain in weight was recorded in nine patients. All made the unsolicited remark concerning the return of the sensation of well being. A high degree of amelioration in reversible cardiac sequelae of hyperthyroidism, improvement in appetite, cessation of diarrhea and diminution or disappearance of tremor were noticed in all patients. The effect on exophthalmos was slight in some cases, more marked in others. A certain degree of exophthalmos persisted in spite of prolonged thiouracil treatment.

As to the local condition, the changes in the thyroid gland were variable. During the first few weeks of treatment the thyroid gland in a majority of cases showed a tendency to increase in size and become softer, especially in patients with a diffuse, parenchymatous goiter, while the toxic adenoma seemed to become firmer but not larger.

After the first few weeks the gland became essentially normal in size only in two patients with a diffuse goiter while in the remaining cases the size and consistency of the goiter were approximately the same as before the treatment. In patients with a toxic adenoma the goiter after the first few weeks did not show any appreciable changes in size or consistency. The recurrent goiter remained unchanged in two patients while in the other three it increased in size.

REACTIONS

Slight reactions in form of nausea, tremor, dizziness and cardiac palpitations were noticed within the first two days after the institution of treatment in six cases out of twenty-one. However, they were insignificant, did not warrant cessa-

tion of treatment and subsided within a short time.

In two cases the toxic side effects necessitated immediate interruption of the treatment with thiouracil. For the sake of brevity only the most essential data pertaining to these cases shall be mentioned.

One patient was a woman, aged seventy-two, with a toxic adenoma and hypertensive heart disease. Her basal metabolic rate at the time of admission to the hospital was +53. She was complaining of cardiac palpitations, dyspnea and choking sensation in the throat. After she had taken nine thiouracil tablets within three days, she developed drowsiness, profuse perspiration, loss of appetite, nausea, vomiting and epigastric distress. Her pupils were contracted and responded poorly to light and accommodation, her respiration became labored and the pulse slow and weak. Administration of thiouracil was discontinued and the patient recovered within two days following the use of stimulants and supportive treatment.

The second patient who did not tolerate thiouracil was a woman, age thirty-five, with a toxic adenoma and a basal metabolic rate of 36. She had been taking thiouracil, 1 tablet three times a day, for twenty days when she suddenly experienced a choking sensation and noticed considerable swelling of her tongue. The symptoms subsided spontaneously within a few hours but returned after the intake of another thiouracil tablet.

Other toxic side effects described in the literature[2,3] such as diarrhea, rashes, fever, jaundice, pruritus, purpura, articular and muscular pains and swelling of salivary glands did not occur in any of the twenty-one patients.

As to the blood changes, no significant drop in the white cell count has been encountered and agranulocytosis fortunately has not been observed. However, six patients developed a relative lymphocytosis, not exceeding 45 per cent, after the first three weeks of thiouracil treatment. This finding alone was not deemed of sufficient significance to warrant cessation of treatment, and periodic blood examinations showed that the neutropenia had a tendency to remain stationary without any inclination to increase. Nevertheless, a restitution of a normal differential blood count was considered desirable. In place of drugs recommended by other authors[4,5] for the treatment of agranulocytosis and granulocytopenia, such as ascorbic acid, pyridoxine, liver extract, pentnucleotide and penicillin, foreign protein injections, using some of the commercial preparations, have been tried with surprisingly good results. After six to ten injections, given every third day, in addition to sizeable increase of the total number of leukocytes, a restitution of the normal differential count was noted. Following this observation a standard procedure was adopted, whereby concurrently with administration of thiouracil the patient was given from the very start one or two hypodermic injections of foreign protein a week, according to the intensity, if any, of granulocytopenia.

COMMENTS

A review of the thiouracil treatment of twenty-one patients with thyrotoxicosis shows that the therapy failed in none of the patients with the exception of two who apparently did not tolerate the drug. On the other hand, no permanent cure has been obtained and the amelioration or disappearance of hyperthyroidism depended on continuation of the treatment. Further observations are required to determine whether such a continuous administration of thiouracil is innocuous and does not produce harmful effects which may escape detection within a relatively short period of treatment. The discussion of usefulness of thiouracil in preoperative treatment of patients with thyrotoxicosis is beyond the scope of this paper. If a thyroidectomy is contraindicated, thiouracil seems to be the drug of choice.

A gradual increase in the daily dose until the customary amount of 0.6 Gm. has been

reached seems to limit the number and intensity of toxic side effects.

If blood examination reveals granulocytopenia, it appears that the latter can be combatted successfully with foreign protein injections. However, according to the latest reports, large doses of penicillin should be given if agranulocytosis develops.

In view of the fact that periodic blood examinations at frequent intervals are essential, the patient should never be given more than one week's supply of thiouracil and the prescriptions should not be refillable.

It is hoped that ultimately a substance related to thiouracil or an entirely different chemical substance will be found, which will have a similar beneficial influence on thyrotoxicosis but without frequent toxic side effects.

SUMMARY

1. Thiouracil proved a highly efficient drug in the treatment of nineteen patients with thyrotoxicosis in whom a thyroidectomy was contraindicated. Two other patients with similar conditions did not tolerate the drug and the treatment had to be discontinued.

2. Cessation of administration of thiouracil is apt to be followed by a relapse of hyperthyroidism.

3. Untoward reactions can be lessened in frequency and intensity by increasing the daily dose gradually until the standard dose of 1 thiouracil tablet three times a day has been reached.

4. Foreign protein injections proved efficacious in combatting granulocytopenia and relative lymphocytosis. They may be given for prophylactic purposes simultaneously with thiouracil treatment before any changes in the differential blood count occur.

5. Periodic blood examinations and determination of the basal metabolic rate and also repeated physical examinations are *conditio sine qua non* when thiouracil is administered. For this reason the patients should never be given more than one week's supply of thiouracil and the prescription should be marked "not refillable."

6. The maintenance dose should be the smallest amount of thiouracil able to keep the basal metabolic rate at a satisfactory level. This dose may be as small as one tablet three times a week.

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THE MANAGEMENT OF CARCINOMA OF THE COLON IN A SMALL GENERAL HOSPITAL*

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MOST articles dealing with carcinoma of the colon and rectum have been published by men working in the larger general hospital, the university hospitals or some of the large private clinics. It occurred to us that it might be interesting to these men, as well as to men working in the smaller hospitals to know of the experience of one working in a rather small general hospital. With this thought in mind, a review of the cases of carcinoma of the colon and rectum managed by us from June 1, 1943, through October 31, 1945, was undertaken, and the findings of this review constitute the basis for this report.

This hospital is listed as having approximately ninety-three beds, is general in type, but attempts to exclude patients with contagious diseases, pulmonary tuberculosis and psychiatric disorders. It is operated, not for profit, under a Board of Directors appointed by the church, and rents office space in its main building to a small group of physicians who practice as a group clinic. Other physicians in the city use the hospital's facilities, but the staff is organized and departmentalized, and only those physicians holding staff appointments are offered these privileges.

The surgery of the clinic group is performed by a surgical team whose personnel is kept fairly constant. The department of anesthesia is under a full time physician anesthesiologist, who is also in charge of all intravenous fluids, blood plasma, and blood transfusions. The laboratory and *x*-ray departments are under the part time direction of a competent pathologist and roentgenologist, respectively. These organizational details are being presented in order to furnish a background for this report, whose primary purpose is to tell of the experiences encountered during the management of these lesions in a small general hospital, and not to present new technics or methods of treatment.

The incidence of carcinoma of the colon may be on the increase. If one becomes interested in this lesion and starts searching for it, he cannot but be impressed by the increasing number which he finds. The importance of the rectal and proctoscopic examination cannot be too strongly emphasized. The aid of an energetic, interested roentgenologist, who is willing to do repeated examinations, is most helpful.

It has seemed to us that most physicians have assumed too pessimistic an attitude toward carcinoma of the colon and rectum. This may be due to the fact that in small centers, the diagnosis of the lesion has been overlooked until distant metastases have occurred and curative treatment out of the question. Surgery has been regarded as an indifferent measure, and due to its high mortality and morbidity, condemned by some. The palliative colostomy patient has presented a sad picture which has tended to discourage the patient, his relatives and his physician, and has played its part in the production of the pessimistic attitude held toward this disease. In one sense of the word this class of patient should serve as a reproof to the medical attendants for not having established the diagnosis earlier.

The operative mortality of these lesions has been lowered considerably in recent years and the late results improved.

* From the Surgical Service of Welborn Memorial Baptist Hospital.

This has been due in a large measure to improvements in anesthesia, in the use of blood transfusions and the sulfonamides. The morbidity has been lowered, the hospital days decreased, and the incidence of multiple stage procedures diminished.

TABLE I
LOCATION OF MALIGNANT LESIONS OF THE COLON

Cecum	2
Ascending colon	5
Hepatic flexure	2
Transverse colon	1
Descending colon	2
Sigmoid colon	7
Rectosigmoid	8
Rectum	12
Total	39

During the twenty-nine month-period under study, there were thirty-nine patients treated by us for malignant disease of the colon and rectum. There were eighteen males and twenty-one females. The average age was fifty-seven. Thirty seven were white and two colored. Figure 1 depicts the location of these lesions, and Table 1 represents a more detailed breakdown of the location of the tumor.

The diagnosis in three cases was established by *x*-ray alone, but one of these had a palpable mass in the region of the descending colon, which served to confirm the *x*-ray diagnosis. In the remaining thirty-six cases the diagnosis was established by operation, sigmoidoscopy and biopsy, or by necropsy.

Twenty-six of the thirty-nine patients were operated upon; the remaining thirteen patients either refused operation or had such extensive disease that surgery was considered hopeless. Of the twenty-six patients coming to surgery, sixteen were considered to have resectable lesions and ten to have so-called non-resectable lesions. In the latter group some had resection of the lesion, but either local or distant metastases made the operation palliative, rather than curative in nature.

Table II depicts the location of the lesion, operative procedure, and hospital mortality of the patients on whom operation was performed. As noted above,

TABLE II
LOCATION OF LESION, NUMBER OF CASES, OPERATIVE PROCEDURE, AND HOSPITAL MORTALITY OF PATIENTS COMING TO OPERATION

Location of Lesion	No. of Cases	Operative Procedure	Hospital Mortality
Rectum and rectosigmoid	6	(1) One-stage combined Abdominoperineal resection	0
Rectosigmoid	4	(2) Ant. resection.-compl. loop colostomy	1
		(1) Palliative loop colostomy; biopsy mesentery	
		(1) Exploration only; biopsy	
Sigmoid	6	(1) Palliative ant. resection; metastases	0
		(2) Mikulicz exteriorizations	
		(1) Exploration, palliative trans. loop colostomy	
		(1) Exploration only; biopsy	
		(1) Loop colostomy obstruction; anterior resection	
Descending colon	2	(1) Trans. loop colostomy; palliative	0
		(1) Loop colostomy for obstruction palliative ant. resection	
Hepatic flexure	2	(1) Cecostomy for obstruction; rt. hemicolectomy; ileotransverse colostomy	0
		(1) Cecostomy for obstruction; Lahey-Mikulicz right hemicolectomy	
Ascending colon	4	(1) Exploration only; metastases	0
		(1) Rt. hemicolectomy—Lahey-Mikulicz	
		(1) Rt. hemicolectomy; ileotransverse colostomy	
		(1) First stage ileotransverse colostomy	
Cecum	2	(1) Rt. hemicolectomy; ileotransverse colostomy	1
		(1) Palliative ileotransverse colostomy	
Total	26		2

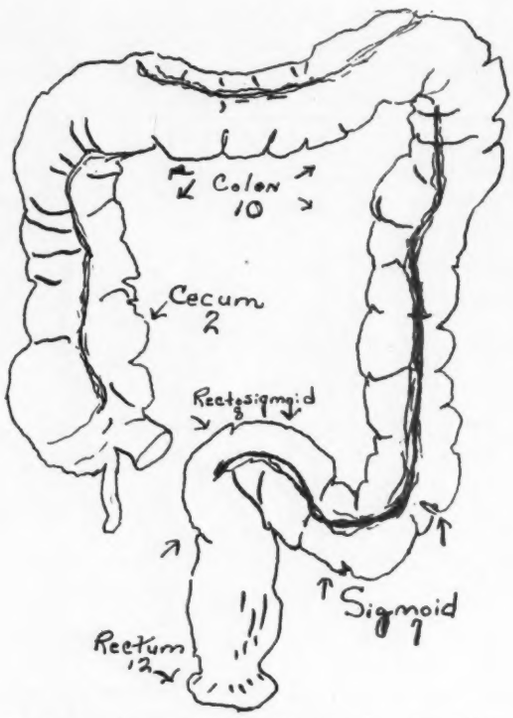

FIG. 1. Location of the malignant growths of the colon and rectum herein reported.

sixteen of these patients had resectable lesions, and in this group the resections were undertaken with the thought of curing the patients. There were no deaths in this group. The patients having palliative procedures usually had extensive local or distant metastases with or without obstruction. Two of them had perforated lesions surrounded by abscess cavities. There were two deaths in this group. They will be discussed later.

Thirteen, or 50 per cent of the patients in the operative group had varying degrees of obstruction, and in all but two cases the point of obstruction was in the left colon. When operative decompression was indicated, it was accomplished through a short, upper, right transverse incision, usually with exploration of the abdomen by palpation and transverse loop colostomy. Two patients had acute obstruction due to carcinomas at the hepatic flexure. They were operated upon through a right transverse incision, and were decompressed by mobilizing the distended cecum and drawing a generous portion of it through a stab wound in the right lower quadrant. Immediate temporary catheter colostomy was performed. The cecum did not retract within the peritoneal cavity.

One patient with an acute obstruction died without operation. He was treated by conservative measures for three days without relief. At autopsy he was found to have a generalized peritonitis from a perforated cecum induced by an obstructing carcinoma of the sigmoid colon. The ileocecal valve appeared to be competent. This probably interfered with the colon decompressing itself by means of regurgitating into the small bowel.

Palliative colostomies were performed as a last resort for uncomfortable, acutely distended patients. It is surprising, at times, how comfortable an inoperable, distended patient can be made with a liquid diet, intermittent gastric suction and opiates. The colon may become irritable in the presence of a remaining lesion, and in such circumstances a colostomy will discharge copiously and make the nursing care difficult. Such experiences as these have brought unjustified criticism on the permanent "curative," colostomy, which behaves in a much better manner.

One patient having an ileotransverse colostomy as the first stage for a growth in the ascending colon, refused to submit to the second stage and as a result died from carcinoma. Latterly, we have done exteriorization procedures or one-stage resections at this level, with a preference for the latter. Primary, open anastomosis, has been used at all times, usually with complementary colostomy, but recently without this possible safeguard. In its absence the anal sphincter is dilated widely in order that flatus may easily escape.

There were two hospital deaths in this series. One occurred in a fifty-seven year old colored female with a perforating carcinoma of the cecum, localized abscess formation, direct extension of the growth to the terminal ileum, emaciation and secondary anemia. The operative pro-

cedure consisted of palliative ileotransverse colostomy and drainage of the abscess. The patient died in shock the afternoon of the day of operation. No necropsy was performed. The second death was that of a thirty-eight year old white male with an obstructing carcinoma of the rectosigmoid, extensive liver metastases, jaundice and cachexia. A palliative transverse loop colostomy was done, and seemed to make the patient's remaining days more comfortable. He died on the ninth day following operation.

The mortality and morbidity rates in patients undergoing surgery for malignant diseases of the colon remain high. These rates are gradually being lowered by better preoperative preparation of the patient with the sulfonamides, blood transfusions and the vitamins. These patients should not be operated upon unless the facilities, including trained personnel, exist for their thorough preoperative preparation. The conduct of the operation itself bears an important relationship to the morbidity and mortality and should be in the hands of a trained team. This team should have an anesthestist who is familiar with some of the problems likely to be encountered, and who is willing to devote hours, if necessary, to the proper conduct of the anesthesia, and its related problems of fluid and blood replacement and stimulation. The surgeon should be assisted by an adequate number of trained personnel. Fine grades of suture materials and properly designed instruments also play an important part in determining the success of the operation.

SUMMARY

1. Some experiences encountered in the treatment of carcinoma of the colon and rectum in a small hospital are reported.

2. Thirty-nine patients with neoplastic disease of the colon and rectum were treated during the twenty-nine-month period studied.

3. Twenty-six of the thirty-nine patients were operated upon. Sixteen of these were considered to have resectable lesions and ten non-resectable lesions. There were two hospital deaths in the patients operated upon.

4. Carcinoma of the colon and rectum can be managed successfully in the small general hospital if a trained surgical team is available.

VAGINOPLASTY

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VAGINOPLASTY is the art of plastic repair of herniations of the urethra, bladder and rectum into the vaginal sheath.

Symptoms in these herniations are urinary disturbances, stress incontinence, the presence of a protruding vaginal mass and a sense of "things dropping out." Relief of symptoms follows effective repair. Successful planning of the repair rests on first hand acquaintance with the structure of the tissues involved. These tissues are the muscles with their investing fascia, which form the pelvic floor,—the levator ani and coccygei. (Fig. 1.)

The vaginal slit is a distensible canal which forms a weak spot in the pelvic floor. As long as the floor is healthy and intact, all is well. If the floor is weak from underdevelopment or disease, or is damaged by injury or infection, herniation develops. In that event we are faced with: a condition of herniation; a problem of effective repair; and a procedure—(a) removal of sac (vaginal wall), (b) replacement of contents (urethra, bladder, rectum), and (c) restoration of supporting wall (pelvic floor).

Urethrocele. (*Herniation of the Urethra*): The urethra begins at the most dependent part of the bladder and follows a slightly curved downward and forward course as far as the symphysis and then tilts upward to end at the meatus. (Fig. 2.) This upward tilt is very important in the problem of repair. The sphincter muscle of the urethra lies in a slit-like pouch formed by the layers of fascia attached to the inner sides of the pubic arch. It surrounds the entire membranous portion of the urethra.

In urethral herniation we have a threefold condition: urethrocele, damaged sphincter and alteration in direction of the canal. (Fig. 3.)

The problem is effective repair of the urethra. Bladder control will not be established if a damaged urethra is left unrepaired.

The procedure comprises removal of the sac by excision, repair and replacement of the urethra by para-urethral fixation with two rows of mattress sutures, the deep row repairing the sphincter and the outer row bringing the fascia together, and the restoration of the upward tilt of the part beneath the symphysis.

The last step may be done in one of two ways: (1) providing a sling by bringing down two strips of fascia from the rectus sheath and uniting them beneath the terminal urethra (Fig. 4); (2) advancing the urinary meatus to just below the clitoris. The meatus is circumcized leaving a collar one-eighth inch wide. Allis clamps are placed directly beneath the clitoris and laterally at each upper myrtiform caruncle, forming a triangle to be denuded. A w suture from collar to clitoris raises the meatus, restoring the upward tilt. (Fig. 5.) Similar sutures are placed at both sides and below, closing the denuded area.

The sling operation is technically more difficult. Practically, it is less effective than the advancement operation. Entire repair of the urethrocele from the vaginal approach is the procedure of choice.

Cystocele. (*Herniation of the Bladder*): The bladder lies behind the pubic bones and in front of the vagina. The base rests against the anterior wall of the vagina and the anterior surface of the cervix to which it is loosely attached by a pair of strong fascial bands, the pubovesical ligaments.

Repair of the cystocele requires: (1) removal of the sac by excision of redundant vaginal mucosa; (2) replacement of the bladder by freeing it from the vagina and

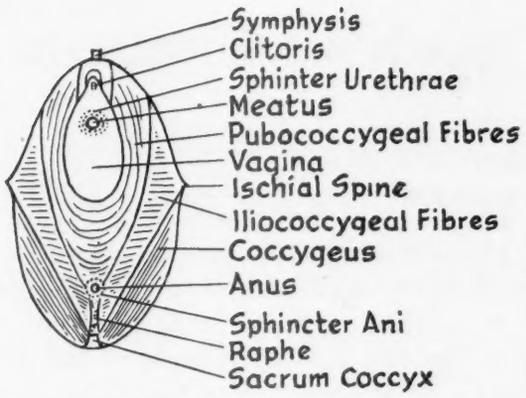

FIG. 1. Schematic pelvic floor.

FIG. 2. Normal urethra.

FIG. 3. Damaged urethra.

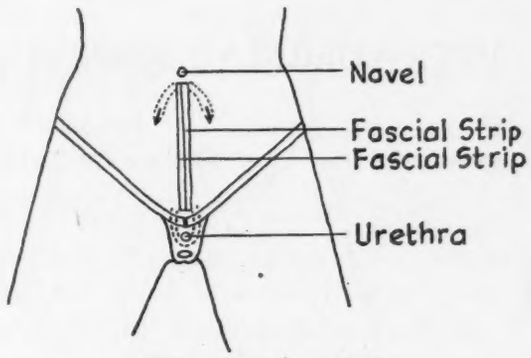

FIG. 4. Sling operation.

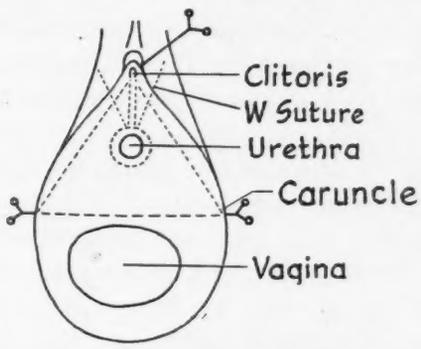

FIG. 5. Advancement operation.

cervix. The cervical attachment of the bladder must be elevated; (3) repair of the supporting wall by bringing together the pubovesical bands of fascia; then uniting the mucosal edges and suturing those below the bladder to the cervix.

A simple plastic operation on the anterior vaginal wall without elevating the bladder and repairing the supporting floor will almost certainly be followed by recurrence of the cystocele.

Rectocele. (Herniation of the Rectum): The lower third of the rectum is enveloped by loose connective tissue which separates it from the vagina in front. Beyond the coccyx the rectum is supported by the pelvic floor which it pierces to become the anus.

The posterior vaginal wall can be pulled fairly taut but this does not permanently overcome a rectocele. To accomplish this it is essential to: (1) free, replace and retain the entire rectocele; (2) bring together the fascial layers and the levator ani muscles from both sides of the rectum. If the first step is not completely carried out, the upper portion of the rectocele will remain and any strain will balloon it out.

In old women the pelvic floor is apt to consist of weak fascia and scant muscle. In these patients it becomes necessary to improvise to bring relief. The interposition and Lefort operations provide practical solutions in selected cases.

These herniations may occur singly but are usually found in combination. Each must be effectively repaired. Art and imagination will direct the performing hand. Duration of repair will be in direct ratio to restoration of basic structure.

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INTRADERMAL SENSITIVITY TEST FOR AMINO ACIDS

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IN the preoperative preparation of surgical patients as well as in the postoperative management of these individuals, protein replacement therapy is a common procedure. One of the most satisfactory methods of re-establishing a positive nitrogen balance, thus restoring protein to a normal level, is to employ amino acids.

The voluminous use of amino acids has demonstrated that many reactions may be associated with its administration. The reactions may be mild, moderate or severe. In our experience we have witnessed one death. Reactions such as nausea and vomiting do occur and are most distressing to patients following gastrointestinal surgery. Flushing, a sensation of warmth and vasodilitation are occasionally observed. Marked vasodilitation has been known to produce a clinical picture simulating anaphylactic shock. Abdominal cramps and pain with or without associated fever is not an uncommon sequel to amino acid injections.

These reactions have been attributed to pyrogens, rapid rate of administration, the glucose solution and the associated administration of sulfa compounds. When all these factors have been eliminated, reactions still occur. Observation has led us to believe that foreign protein sensitivity is the underlying cause. With this belief as a background, we have employed the routine procedure of intradermal sensitivity test for amino acids.

This intracutaneous test is performed by injecting a small amount of the amino acid solution between the layers of the skin. The test is usually made on the flexor surface of the forearm or the outer aspect of the thigh. In making the test it is most convenient to use a tuberculin type syringe. The needle should be the intradermal size, No. 27 gauge, short bevel. The total amount of solution injected is 0.01 cc. A positive reaction is revealed by redness, heat, swelling and urticarial wheals at the site of injection. Findings such as these preclude the administration of amino acids. The presence of one of these reactions as elicited by the intradermal test warns against the use of the amino acid solution employed in the test. It is interesting to note that a patient may be sensitive to the amino acids manufactured by one company and not to the amino acids from another pharmaceutical house.

Skin tests have been performed after reactions have occurred. Tests of this type have demonstrated that the intradermal test is not only qualitative but also quantitative in that unfavorable systemic reactions were directly proportional to the skin reactions. This procedure has been very simple to follow. On the occasions when a skin test has been employed prior to the parenteral administration of amino acids, it is believed that severe reactions to amino acid intravenous therapy have been avoided.

Case Reports

SURGICAL REMOVAL OF LEIOMYOMAS OF THE ESOPHAGUS

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BENIGN tumors of the esophagus are of considerable interest because of their comparative rarity and because they lend themselves to surgical removal. These characteristics are in contradistinction to those of malignant tumors of this region which are relatively common but are much less amenable to treatment.

A wide variety of benign neoplasms may arise from the esophagus[2] including adenoma, fibroma, hemangioma, leiomyoma, lipoma, lipomyoma, mucocele, myoma, myxofibroma, neurofibroma, papilloma and polyp. In a series of 7,459 postmortem examinations performed at the Mayo Clinic, thirty-two of forty-four benign tumors found in the esophagus were leiomyomas.[3]

In a review of the literature from 1717 to 1932, Patterson[4] found only sixty-two cases of benign tumor of the esophagus. Harrington and Moersch[1] reported a total of fifteen cases of benign tumors of the esophagus from a review of 11,000 cases encountered at the Mayo Clinic in which dysphagia was present.

Benign tumor of the esophagus may occur at any age but is more frequent in the later decades. It is more common among men. The lesions which may be single or multiple, vary greatly in size and may arise at any point in the esophagus.

Benign tumors of the esophagus may be divided into two groups on the basis of their site of origin. The first group is comprised of those tumors arising from the mucosa or submucosa and are commonly known as mucosal tumors. They are covered by normal epithelium and are often pedunculated. When they are pedunculated, the tumor may be regurgitated by the patient. The second group of tumors arise from the outer coats of the esophagus and are described as intramural or extramucosal growths.

The production of symptoms from these tumors depends on the site of origin, location, size and rate of growth. Most of the tumors grow slowly and many never produce symptoms. The most frequently noted symptoms associated with benign tumors of the esophagus are dysphagia, substernal pain, regurgitation of food, cough and dyspnea.

Diagnosis of benign tumor of the esophagus may be relatively easy when a patient gives a history of regurgitation of a mass into the mouth. Under other conditions, however, diagnosis may be difficult even when the most useful adjuncts of roentgenography and esophagoscopy are employed.

Because of the potential danger of malignant change in these tumors, surgical removal should be considered in all cases.

CASE REPORT

The patient, a man, aged fifty-two years, came to the Mayo Clinic September 10, 1945, complaining of substernal distress of ten years' duration. He had experienced only one or two mild attacks a year and had noticed slight difficulty in swallowing associated with them. He had not regurgitated food, nor were his symptoms related to the type of food eaten.

FIG. 1. Intramural tumor in the middle third of the esophagus and a small tumor above this.

FIG. 2. Intramural leiomyomas of the esophagus.

Five years before entry to the clinic he complained of occasional attacks of epigastric pain that were not related to his substernal distress. One year later he had been treated for peptic ulcer without benefit. In April, 1945, he consulted his physician in his home locality who reported, later when he referred the patient to the clinic, that some of the symptoms had been suggestive of a duodenal ulcer, but that the patient had had no pain at night and had experienced incomplete relief from pain after eating. The results of physical examination which included an electrocardiogram at that time were essentially negative. The physician advised the patient to return if his distress recurred. In July, 1945, he had another attack and again consulted his physician. Roentgenologic examinations of the gallbladder, stomach, duodenum and colon gave normal results. Roentgenologic examination of the esophagus revealed a compression and deviation of the middle third of its wall by a lobular mass approximately 7 cm. in diameter. The patient was referred to the clinic for further diagnostic studies and advice on treatment.

When the patient was examined at the clinic, his general condition was good. The systolic blood pressure was 110 mm. of mercury and the diastolic pressure was 74 mm. The value for the hemoglobin was 14.4 Gm. per 100 cc. of blood. The leukocyte count was 9,600 per c.mm. of blood. The cause of his father's death at the age of sixty years was a probable carcinoma of the stomach. A sister had died as the result of carcinoma of the breast.

A roentgenogram showed a large, intramural tumor in the middle third of the esophagus. Just above this was a smaller but similar defect. (Fig. 1.) A tentative probable diagnosis of leiomyomas of the esophagus was made. Examination of the stomach did not disclose any abnormality.

Esophagoscopic examination revealed two tumors in the esophagus. The upper one was located at the junction of the upper and middle thirds of the esophagus and arose from the left lateral wall; it measured about 2 cm. in diameter. The lower, larger tumor arose from the anterior and left lateral wall of the middle third of the esophagus and projected into the lumen; it measured approximately 6 cm. in diameter. Both tumors were covered by normal and intact mucous membrane. The appearance was suggestive of fibrolipomas, but the location was more characteristic of that of leiomyomas. Biopsy was not performed because operation was contemplated and it was considered inadvisable to enter the esophageal mucosa.

Penicillin was given for forty-eight hours before operation as prophylaxis against infection. On September 17, 1945, left thoracotomy was performed utilizing a posterolateral incision around the angle of the scapula. A long segment of the fifth rib was resected and the pleura was opened. The larger esophageal tumor was immediately beneath and adjacent

to the arch of the aorta. It was broader than it was long, measuring about 7 by 3 cm., and projected into the right pleural space. The smaller tumor, measuring about 2 cm. in diameter, was higher in the esophageal wall beneath the arch of the aorta. Both tumors were hard and cartilaginous and were located within the muscular wall of the esophagus. A good line of cleavage was found and the tumors were dissected out of the muscular wall without entering the mucosa. The defect in the muscularis was closed with catgut. The operative site was irrigated with solutions of sodium chloride and zephiran chloride. Five Gm. of sulfanilamide was placed in the pleural cavity. The lung was inflated by means of positive pressure and the wall of the thorax was closed in layers without drainage. During the operation, a transfusion of 500 cc. of citrated blood was given.

Pathologic examination disclosed that the tumors were leiomyomas. The larger tumor was lobulated and measured 8 by 3 by 3 cm.; the smaller tumor measured 2 by 1 by 0.5 cm. (Fig. 2.)

Convalescence was entirely uneventful. Feedings were given through a Levine tube for forty-eight hours postoperatively and then the patient was given food by mouth. He was out of bed on the fourth postoperative day and was dismissed from the hospital on the twelfth postoperative day.

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PNEUMOCOCCAL ARTHRITIS

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PNEUMOCOCCAL arthritis is a rare type of articular inflammation appearing usually as a complication of lobar pneumonia and seen most frequently in adults. It is possible for the primary focus to be obscured by the severity of the local and constitutional reaction of the arthritis itself to the extent that the involved joint appears as a primary process.

Boger in a comprehensive review of the literature cites a total of 227 cases beginning with the first reported case in 1888 by Weichselbaum.

In quoting Herrick's data, there were ninety-seven cases of pneumococcal arthritis occurring in a series of 31,757 cases of pneumonia, an incidence of 0.3 per cent.

In young children the arthritis may be the manifestation of a general pneumococcal septicema or the general signs of infection may be absent, the bacteria being carried to the affected joint from some focus such as the tonsil. As a rule only one joint is involved, the knee being the most common site. The inflammation may advance to any stage, the joint being distended with greenish, odorless pus containing large numbers of pneumococci.

CASE REPORT

F. W., an obese colored female, age sixty-nine years, was referred to the Passavant Hospital November 8, 1944, suffering from a swollen painful left knee with contiguous swelling of the adjacent soft parts, symptoms of a severe septicemia and a large decubitus ulcer. She had been ill at home for four weeks having suffered a sudden onset of generalized joint pains involving the fingers and elbows of both upper extremities, pain in her lower back, both hips and knees, with the maximum swelling and discomfort settling in her left knee.

Her past medical history was negative in regards to pneumonia or rheumatic fever. There was no previous history or association with the present illness of cough, pain in the chest or hemoptysis. She was transferred to Surgery on November 15, 1944, at which time she had a tense, markedly swollen left knee joint, sensitive to touch, and she was unable to carry out either active or passive motion. A blood culture taken November 10, 1944, was positive for pneumococci type III. Her temperature was 102°F., pulse 134 and respirations 36. Sulfadiazine gr. 15 every four hours had been started November 13, 1944.

On November 16th, under gas oxygen anesthesia the joint was aspirated and green odorless pus under great tension obtained. Following culture of the pus the joint was opened by lateral incisions, the pus evacuated and Dakin tubes placed down to but not within the joint. Iodoform gauze packing was used to control marked oozing. The patient's temperature returned to normal following incision and drainage and Dakin's solution were used for irrigation until November 19th when the tubes and packing were removed and daily passive motion begun. The sulfadiazine was discontinued November 29th. a blood culture taken November 22nd showed no growth after seven days. The culture from the aspirated pus contained pneumococci type III.

The decubitus ulcer was healing under local treatment and a routine culture on January 4, 1945, yielded Streptococcus non-hemolyticus and Staphylococcus aureus. A walking cast was applied January 13, 1945, to prevent any posterior contracture of the knee and aid the patient in getting about. A carious tooth and several root remnants were removed February 7, 1945, and cultured; the swabs yielded Staphlococcus aureus.

An *x*-ray examination before incision and drainage November 11, 1944, revealed a very extensive arthritis of the left knee joint. A re-examination on December 29, 1944, revealed practically complete destruction of the semilunar cartilages. There was new bone production present about the lower end of the femur and the upper end of the tibia.

The patient was discharged February 14, 1945, with slight limitation of motion in her left knee joint.

COMMENT

A case of primary pneumococcal arthritis, Type III, was observed and no evidence found of a prëexisting pneumonia. Existing dental infection and a decubitus ulcer were both studied bacteriologically and ruled out as possible sources of primary foci. The infection was sudden in onset with generalized joint pains, prostration, a pneumococcal bacteremia and suppuration of the left knee joint. Chemotherapy in the form of sulfadiazine started three days prior to incision and drainage lacked the dramatic effect of the operative procedure but undoubtly was the specific factor in recovery.

The *x*-ray studies revealed joint destruction especially of the cartilages, a condition common to pyoarthritis in general in which cartilage is rapidly destroyed when incubated with pus. Incision and drainage is especially indicated in fulminating cases; however, the availability of penicillin may make this unnecessary as repeated aspiration of pus and the instillation of penicillin directly into the joint may be the only treatment necessary.

With the exception of the streptococcal case, established infection of the hand and fingers should receive energetic surgical treatment at as early a stage as possible. Damage may be done, both by delay and by too vigorous and extensive initial treatment, but there can be no doubt that the commoner errors are those of delay and timid surgery.

From "Minor Surgery" edited by Humphry Rolleston and Alan Moncrieff (Philosophical Library).

ABDOMINAL SKELETINIZED FETUS

WITH UTEROPERITONEAL FISTULA SECONDARY TO CRIMINAL ABORTION

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TWO possibilities present themselves as possible explanations for the development of the condition found in this case. The first, and apparently the more satisfactory explanation, is that the pregnancy was originally intra-uterine. When the instrumentation of the uterus was performed, the uterus was ruptured. The fetus was then extruded into the abdominal cavity as a result of uterine contractions, leaving a uteroperitoneal fistula and explaining the patient's abdominal pain. The fetus then became skeletinized, and fetal bones were passed from time to time through the uteroperitoneal fistula. The only case of this type found in the literature was described by Blakely in 1920.[1] In his case, a self-instrumentation of the uterus was done three months after the patient's last menstrual period. One month later an instrumentation of the uterus was performed under anesthesia and this was followed by severe abdominal pain. A mass became noticeable in the abdomen. The patient was treated conservatively and she recovered. It was then noted that a vaginal fistula in the posterior cul-de-sac had formed with a mass lying behind the uterus. Nine months after onset of pregnancy, a fetal skeleton was removed from the posterior cul-de-sac from below, and it was found lying in a smooth lined cavity which was then thick walled and did not communicate with the peritoneal cavity.

Frommolt, in 1934,[2] reported a case in which criminal abortion was done, and on removal of the fetus from below, the head was found to be missing. The patient was admitted to a hospital and a laparotomy was done. The uterus was found to be perforated, and the fetal head was found lying free in the abdominal cavity.

The second possibility is that the pregnancy was originally abdominal, and, becoming skeletonized, eroded into the uterine canal. A case of this type was reported by Gabrieljantz[3] in 1924. This patient a para 1, became pregnant and noted fetal movements at four months. After eight months of pregnancy no further movements were noted, and the patient developed a foul smelling vaginal discharge. She had no bleeding, pain or collapse, though she did pass two small bits of bone which had the appearance of rib. On examination the abdomen was found to be tense, with a mass occupying the entire lower abdomen. Roentgenographic examination revealed a calcified extra-uterine fetus, and a diagnosis of lithopedian was made. Operation was performed, and a large encapsulated cavity was encountered containing the decomposing products of an eight months' gestation. The cavity communicated with the uterine canal, and examination of the fetus revealed that three ribs and the small bones of one hand were missing.

Skeletinized abdominal fetuses have eroded into the rectum, as reported by Gustafson[4] in 1932, into the bladder and cecum, as reported by Cullen[5] in 1915 and through the abdominal wall, as reported by Schewket[6] in 1930. Gould and Pyle[7] reported that fetal bones have eroded into the intestinal tract and have even been vomited.

CASE REPORT

This thirty-year old mother of four children was admitted to the hospital on July 27, 1945, complaining of foul smelling vaginal bleeding

Fig. 1. Schematic drawing illustrating abdominal skeletinized fetus with uteroperitoneal fistula as observed at operation.

and passage of small pieces of bone of one month's duration. Her menstrual periods had been regular and normal until five months previously. She then missed two menstrual periods. Two months before admission the patient had been told that she was pregnant and an attempt at instrumental criminal abortion was made. Thereafter, the patient became very ill, passing considerable amounts of blood and complaining of severe abdominal pain and vomiting. She was confined to bed at home for about three weeks during which time her complaints subsided. One month before admission she began to pass small pieces of bone and the discharge became foul smelling. A second instrumentation of the uterus was performed in an abortionist's office one month before admission. Thereafter the bloody discharge continued unabated and bits of bone were passed occasionally.

Physical examination on admission revealed a somewhat obese woman whose abdomen was soft and relaxed. Her heart and lungs were normal. The cervix was small, smooth, and firm with foul, reddish, purulent material emerging from the os. The uterus was enlarged to about twice normal size and was in second degree retrocession. Anterior and to the left of the body of the uterus and attached to it there was a soft, tender, nodular area measuring about 4 cm. in diameter. The adnexal regions were somewhat thickened and tender. The ovaries were not palpated. The examination was otherwise essentially negative.

A Friedman test was reported as negative, and a roentgenogram of the pelvis revealed "several densities in the left side of the pelvis having the appearance of fetal bones." Other laboratory studies were within normal limits.

Under the impression that the patient had a missed abortion and uterine leiomyomas, operation was performed on August 3, 1945. After routine preparation and draping the uterine sound was passed and a grating sensation was noted. Without resistence the sound was passed to its full length. Because of the presence of evidence of endometritis and rupture of the uterus, laparotomy was decided upon.

The patient was placed in the supine position and after routine preparation and draping of the abdomen, a low mid line incision was made and the abdomen opened. There was a slight amount of free blood in the peritoneal cavity. The uterus was enlarged, boggy and in retrocession. Anterior to the uterus and to the left

of the body just above the reflection of peritoneum over the bladder, a cavity measuring about 4 cm. in diameter was noted. Lying free in the cavity there were about ten small fetal bones. These were removed. A sound was passed into the base of the cavity and a tract was demonstrated which passed into the cervical canal. The findings are illustrated in Figure 1. Since the opening into the cervical canal was fairly large and the anterior wall of the uterus thin and eroded, it was considered inadvisable to attempt closure of the area. Therefore, a supravaginal hysterectomy was done. Pathological examination revealed moderate chronic endometritis with no decidual or placental tissue in the endometrium.

Postoperatively the patient developed a pelvic abscess which was drained through the cervical stump. A wound infection also developed and drainage was required. The patient then recovered uneventfully and she was discharged from the hospital with no complaints on September 7, 1945.

SUMMARY

A case is reported in which, following a criminal abortion, the patient developed severe abdominal pain and vomiting which gradually subsided. She then developed a foul smelling vaginal discharge and passed fragments of fetal bone. At operation an abdominal skeletinized fetus with a uteroperitoneal fistula was discovered. Two possible explanations for the development of the condition are presented.

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SKELETAL TRACTION IN THE TREATMENT OF MULTIPLE FRACTURES OF THE THORACIC CAGE*

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THE increase in automobile accidents recently makes the author believe that this is a timely report of a rather simple procedure which can be a life-saving measure for the patient with multiple fractures of the sternum and/or ribs. The physiology associated with the "stove in chest" has recently been discussed[1] so there is no need to dwell on this. However, the treatment reported in the same article involves the use of the Drinker respirator. The Drinker respirator is not always available for the treatment of the patient with the "stove in chest." Other treatments suggested have been open reduction with and without internal fixation, the insertion of tenaculi, and even the passage of a wire beneath the sternum.[3,4,5] These procedures involve more or less a type of surgery that the patient is in poor condition to undergo. They also involve certain dangers, such as laceration of the internal mammary artery and tear of the pleura. Therefore, a relatively simple procedure is described and a case reported.

TECHNIC

Under novocaine anesthesia a stab incision is made over the sternum in the midline and carried down through the periosteum. Into this incision a small drill point is inserted and a hole drilled into the ventral cortex of the sternum. A medium sized common clothes closet question mark type of coarse threaded hook with tapered point is then inserted in the small drill hole, and with four or five turns it is well fixed in the sternum. In similar fashion a second hook is placed in the other fragment and traction applied. A double wooden crossbar is placed between these hooks for external fixation later. The placing of the hooks takes only a matter of a few minutes.

Experiments on cadavers revealed that there was no danger of piercing the posterior cortex with the hook if only five turns were taken. However, care must be taken to avoid drilling through the posterior cortex. To avoid this a drill with an adjustable guard may be used, although one can easily feel the drill pierce the ventral cortex and stop then.

CASE REPORT

A fifty year old white merchant was admitted to the Robert Packer Hospital late on the night of December 11, 1944, after being injured in an automobile accident while he was driving. The essential physical findings included a laceration above the right eye in a somewhat dazed patient. Examination of the chest revealed paradoxical motion of the sternum in that with each inspiration this bone seemed to be drawn into the chest. Palpation revealed a transverse fracture at the junction of the middle and lower thirds. There also appeared to be chondrosternal fractures, third, fourth, fifth, and sixth, on the right and fourth and fifth on the left. With each inspiration the sternum sagged markedly at the fracture site. The blood pressure was 90/60, pulse was 96 per minute, of good quality and regular. Respiratory rate was 32 per minute, temperature 99.2°F. There was no evidence of pneumothorax.

The patient seemed to be in fairly good condition, but by the time the laceration had been sutured respiration became labored and blood pressure had fallen to 60/44(?). Antishock therapy was instituted and the patient

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FIG. 1. One hook is shown in place. The lower one attached to the other pulley had just been removed.

responded very well. The patient was placed in an oxygen tent.

The following morning, his temperature was 100.4°F., pulse was 80 per minute, and respiration was 28 per minute. The patient was experiencing considerable pain at the sites of fracture on respiration. All tender points were injected with 1 per cent novocaine with relief of pain on respiration, but the paradoxical motion of the sternum persisted. The lower chest was strapped circumferentially with adhesive but this increased the patient's discomfort and it was immediately removed. Respirations dropped to 18 per minute and the temperature was down to 98.8°F. that evening. The next morning the fracture sites were again injected with 1 per cent novocaine to relieve residual pain. Temperature was 99°F., pulse 20, and respiration 24. The sagging of the sternum persisted. Since it was obvious that vital capacity was cut down considerably, a plan of treatment was worked out to combat respiratory difficulty and/or pneumonia should it develop. This was fortunate since that is exactly what happened suddenly that night. The temperature went from 99°F. to 103.6°F. Pulse was 110 per minute and respirations 50 per minute. There were signs of consolidation in the left lower lobe. Penicillin treatment was instituted.

Under novocaine anesthesia two towel clips were inserted deep in the soft tissues over the sternum and two two-pound weights were used as traction on these. This was an emergency measure and helped the patient considerably. Respirations immediately dropped to 40 per minute after traction was applied. The following morning, it was believed that the skin would not stand up under prolonged traction,

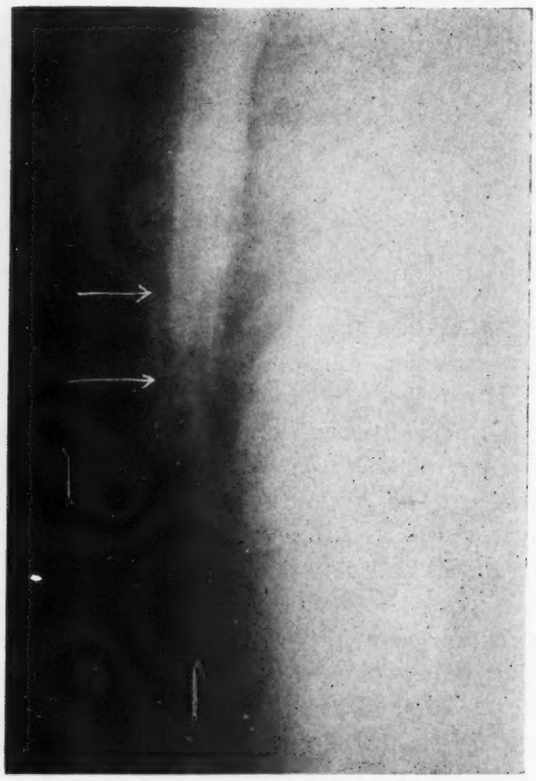

FIG. 2. Lateral view of the sternum showing the fracture at the junction of the middle and lower thirds of the gladiolus.

and the sternum still appeared to sag somewhat on inspiration in spite of the skin traction. Therefore, two hooks were placed in the sternum, one in each fragment as described above under novocaine anesthesia and traction was applied to these. This prevented the sagging of the sternum on inspiration but as a rocking motion was noted, a wooden bracket as a sort of external fixation bar was placed between the two hooks. The patient made a remarkable clinical improvement. Respirations dropped to 24 per minute in the course of the hour. The patient was not put back in the oxygen tent.

In three days temperature, pulse and respiration were normal. Traction was continued for eight days in all, at the end of which time releasing the weights for several hours caused no appreciable change in the patient's condition or the mobility of the sternum. The hooks were then removed without discomfort to the patient, a photograph being taken after one hook had been removed. (Fig. 1.) *X*-ray taken the following day demonstrated the fracture of the sternum. (Fig. 2.) Three days later the patient was discharged completely asymptomatic.

It would appear that this procedure would be useful in any chest injury with multiple fractures in which a segment of the thoracic cage including the sternum became so mobile that its movement interfered with the maintenance of the normal negative intrapleural pressure. The procedure has been used on a boy, aged nine, with excellent results, as well as the case reported.

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The commonest cause of delayed union in closed fractures is inadequate splinting. Fractures in certain locations as the neck of the femur and the wrist joint unite more slowly than the average. Most cases respond to further immobilization and frequent application of heat.

From "Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (The Williams & Wilkins Company).

BARIUM AS A FACTOR IN INTESTINAL OBSTRUCTION

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THE surgeon is too frequently asked to see a patient who has developed a complete intestinal obstruction during the course of a roentgenographic examination of the gastrointestinal tract. It has not been an uncommon procedure for many to have a gastrointestinal *x*-ray series carried out in a patient who presents minimal signs and symptoms of a low intestinal obstruction. The roentogenologist gives the barium by mouth and follows its course throughout the intestinal tract. In some cases the obstruction may be of a sufficient degree that a substance of the density of barium will not pass through and a complete obstruction will be produced. A recent case in which this occurred, and in which the barium in the intestine created the greatest problem, was thought to be of sufficient interest to report.

CASE REPORT

A seventy-one year old female went to her physician because of vague, abdominal, crampy pains which had been present for approximately two weeks. These were associated with an indefinite type of dyspepsia. His examination was essentially negative and the patient was referred for gastrointestinal roentgenographic studies. She was given barium by mouth, and within twelve hours had developed a classical picture of acute large intestinal obstruction. (Fig. 1.) The roentgenograph at this time showed an almost complete intestinal obstruction at the hepatic flexure of the colon. The abdomen was distended with dilated loops of barium-filled small intestine. The patient had acute distress and was vomiting. It was necessary to hospitalize her and to institute continuous intestinal suction, to give intravenous fluids and sedation and to use most of the accepted measures for relief of the obstruction. Approximately one week was required to deflate the intestine and to prepare the bowel sufficiently so that elective surgery could be contemplated.

At operation, the hepatic flexure of the colon was obstructed by a "napkin ring" type of carcinoma. There was a lumen of approximately 1 cm. at the site of the obstruction. Some barium was still present in the proximal colon and small intestine. A resection of the right colon with a transverse eleocolostomy was performed. The patient made an uneventful convalescence and left the hospital on her eighteenth postoperative day.

COMMENT

It is not unusual, as in this case, for a patient to have a nearly completely obstructed colon and to have relatively few symptoms. This is particularly true when the lesion is located in the right half of the colon because of the soft, semi-fluid state of the bowel matter in this region. When a substance with the consistency of barium is given by mouth to such individuals, it will often precipitate a complete obstruction, as occurred in this case. When this occurs, one has converted an uncomplicated problem into a complicated one, and has inadvertently increased the risk and reduced the patient's chances of recovery. This situation will usually be avoided if a barium enema is given first to all those patients in whom the possibility of a lesion in the lower intestinal tract is considered. When barium is given by this route and an obstruction encountered, the barium, which of course is distal to the obstruction, can readily be removed by an enema.

This approach to the roentgenographic examination of such patients not only has the greatest factor of safety, but is more accurate from a diagnostic standpoint, requires less time and is less expensive. I believe that a gastrointestinal *x*-ray

Fig. 1. Barium filled intestine with obstruction.

series should rarely be ordered as such, but that one should request examination of the stomach and duodenum, the small intestine or the colon as separate entities depending on the symptoms and findings presented. I am certain that this is generally the commonly employed procedure. However, all too frequently barium is administered by mouth to individuals with signs and symptoms of a low intestinal obstruction, and as a result, the barium proves to be a factor in precipitating a complete intestinal obstruction when such might have been avoided.

SUMMARY

A case has been reported in which barium administered by mouth during the course of roentgenographic examination of the gastrointestinal tract proved to be a factor in the intestinal obstruction.

New Instruments

METACARPAL FRACTURES

A NEW INSTRUMENT FOR THE MAINTENANCE OF POSITION AFTER REDUCTION

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DEFORMITIES of the hand frequently result from simple metacarpal fractures because of the difficulty of maintaining position after reduction. These fractures are characteristically found in the young or middle aged man, usually the result of a pugilistic encounter, or close hand-to-hand combat with the enemy in time of war. The neck of the metacarpal, being the smallest and weakest portion of the bone, is the most common site of the fracture. The fracture is more frequently transverse in character. The resulting deformity is that of a depression of the head with dorsal angulation of the fragments. The more dorsal the striking force against the head, the greater is the depression of the knuckle. The more direct the force on the head in the longitudinal axis of the metacarpal, the greater the degree of impaction. A tangential force results in depression of the head with impaction and angulation of the fragments.

Ordinarily in this type of fracture, a simple roll of gauze bandage is placed in the palm of the hand. The fist is clenched and immobilized with another gauze bandage. Some recommend bandaging the hand over a tennis ball. More complicated and specialized devices have met with success in the hands of others. Kaplan[1] explains a device for reducing the fracture and holding it in position by the application of an unpadded cast made of two narrow plaster of paris splints. The finger is held in extension and pressure is instituted below the head of the metacarpal and above the angulation while the plaster sets. Meltzer[2] employes skeletal wire traction through the proximal phalanx. McNealy and Lichtenstein[3] maintain the corrected position with a straight dorsal splint. Wertheim[4] advocates a kid glove into the finger of which he inserts ⅛ inch shoe leather to act as a splint. Carr[5] corrects and maintains the position of the fragments by inserting specially constructed miniature ice tongs into the proximal phalanx.

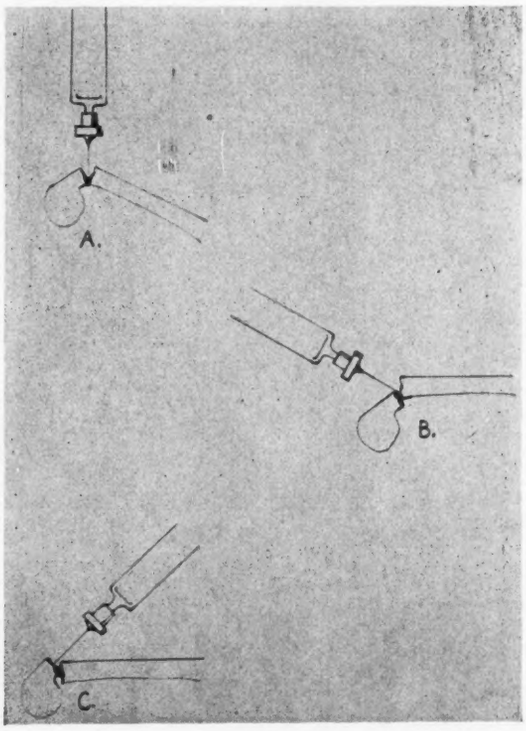

FIG. 1. A schematic drawing demonstrating the various directions of the hypodermic needle to facilitate striking the hematoma at the fracture site. At this point about 5 to 10 cc. of a 1 per cent solution of novocaine is injected in order to produce analgesia.

Fig. 2

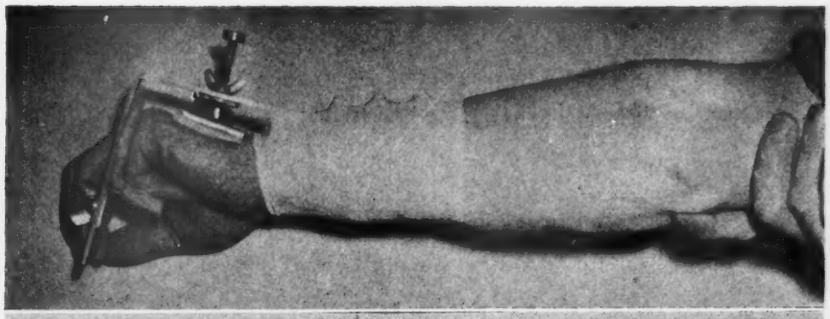

Fig. 3

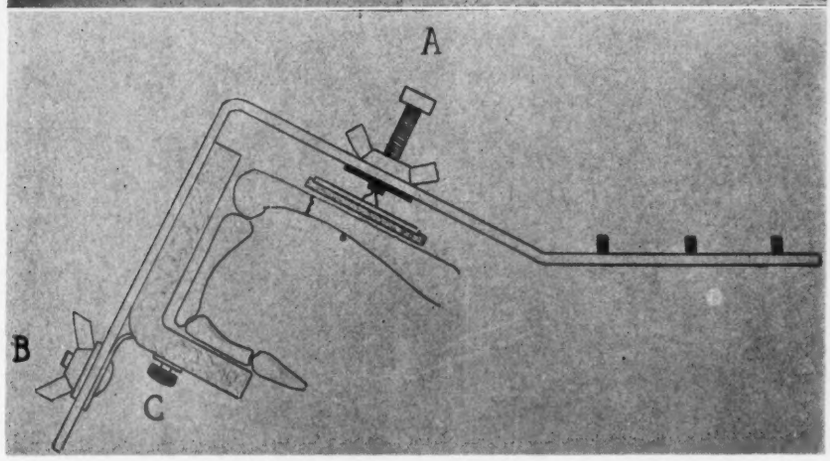

Fig. 2. A photograph of the instrument applied to a fracture through the neck of the fifth metacarpal.

Fig. 3. A schematic drawing of the instrument applied to a fracture through the neck of a metacarpal: A, set screw to adjust upper plate; B, set screw to adjust lower plate; C, set screw to permit rotation of lower plate so as to conform with the deviation of the finger.

Bosworth[6] first reduces the fragments, then maintains position by fixing them to the adjacent metacarpal with non-flexible heavy wires. Jahss[7] maintains the position of reduction by employing pressure beneath the head of the flexed proximal phalanx, a procedure similar in certain respects to that recommended in this paper. Davis[8] maintains position over various sizes of specially constructed wooden balls.

Since this type of fracture is usually first seen by the general practitioner, it is invariably treated by him with one of the many simpler methods available. Unfortunately, in this fracture which is so easily reduced, it is difficult ordinarily to maintain the corrected position. In consequence, many individuals are left with a residual deformity. This deformity in the laborer interferes with his grasp of an implement. The inability to flex the affected finger completely, results in a weakness of the flexion power of the adjacent fingers. The prominent head of the metacarpal in the palm of the hand causes pain when an object such as a tool is grasped. The professional man, too, finds that this deformity interferes with the full use of both the affected and the adjacent fingers. The depression of the knuckle and the prominence on the dorsum of the hand is cosmetically objectionable to women.

The ball or roll of gauze in the palm of the hand does not counteract but rather emphasizes the angulating pull of the interossei muscles thereby increasing the deformity. Skeletal traction of any form or skeletal fixation introduces the danger of infection and must be considered a specialized procedure. When plaster is used, it is too difficult for the average physician to determine the exact amount of pressure necessary to maintain the position of the fragments. Too much pressure will result in pressure sores during the swelling stage which ensues within a few hours following

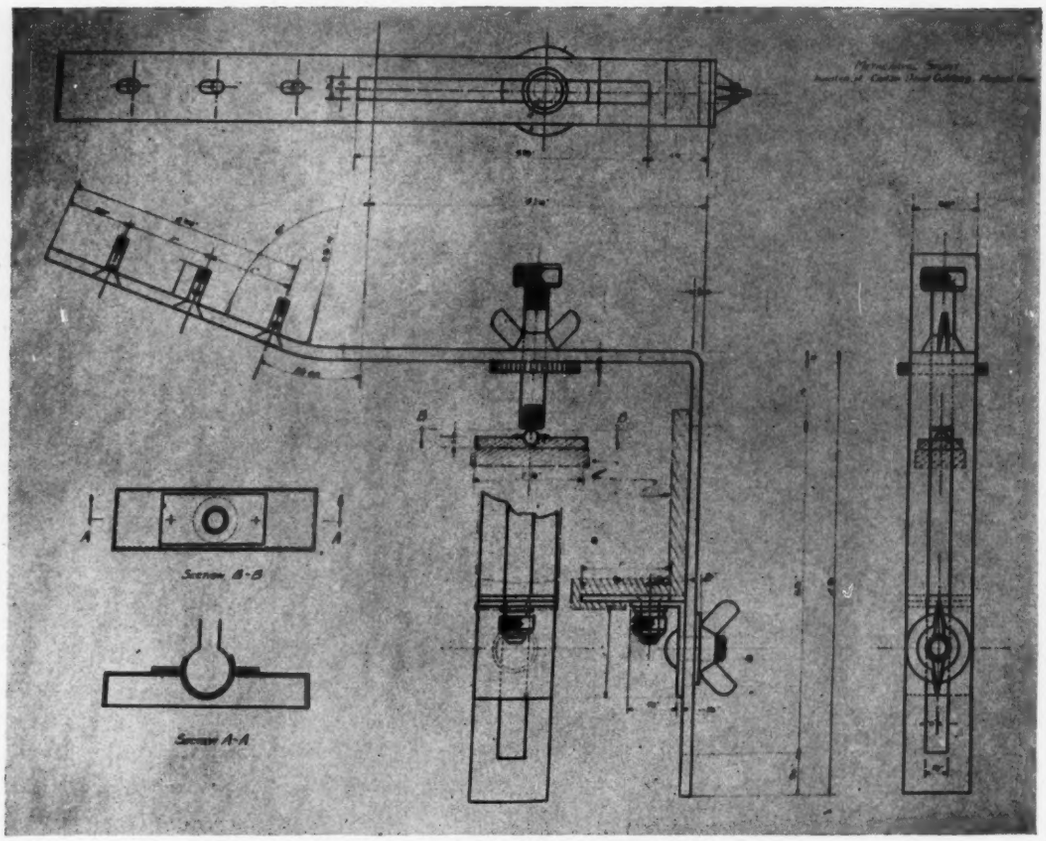

FIG. 4. A mechanical drawing of the instrument.

the reduction. Too little pressure will result in reangulation when the swelling subsides. Constant immobilization of the flexed proximal interphalangeal joint, as advocated by Jahss,[7] for a period sufficient to see callous on the *x*-ray film, often results in a flexion deformity.

The instrument to be described is devised primarily for application to the most common type of metacarpal fracture. This, as has been stated, is the simple, transverse, impacted fracture of the shaft. Discussion will be limited to the diagnosis, reduction, immobilization, and after-care of this injury.

Diagnosis. The diagnosis is easily established. There is a history of trauma, swelling, and localized tenderness. Examination shows a depression of the knuckle or head of the metacarpal, protrusion of the metacarpal head into the palm of the hand, and dorsal angulation of the fragments. The latter results in a prominence on the dorsum of the hand. Such findings warrant *x*-ray study. The anteroposterior view will best show the site of the fracture, while the lateral view demonstrates the degree of angulation and impaction of the fragments.

Treatment. Analgesia is produced by the injection of 5 to 10 cc. of 1 per cent solution of novocaine into the hematoma at the fracture site. The relationship of the fracture line to the head of the metacarpal, and the angle it assumes with the dorsum of the shaft, are determined by the *x*-ray film. Because of the dorsal angulation of the fragments, the widest portion of the fracture line is located at the dorsum of the shaft. Since the dorsal aspect of the shaft is rather superficial, it is a simple matter to direct the needle into the fracture line and thus strike the hematoma. The direction of the needle will depend entirely upon the course of the fracture line. (Fig. 1.)

Soft tissue swelling during the period of injection indicates that the solution is being

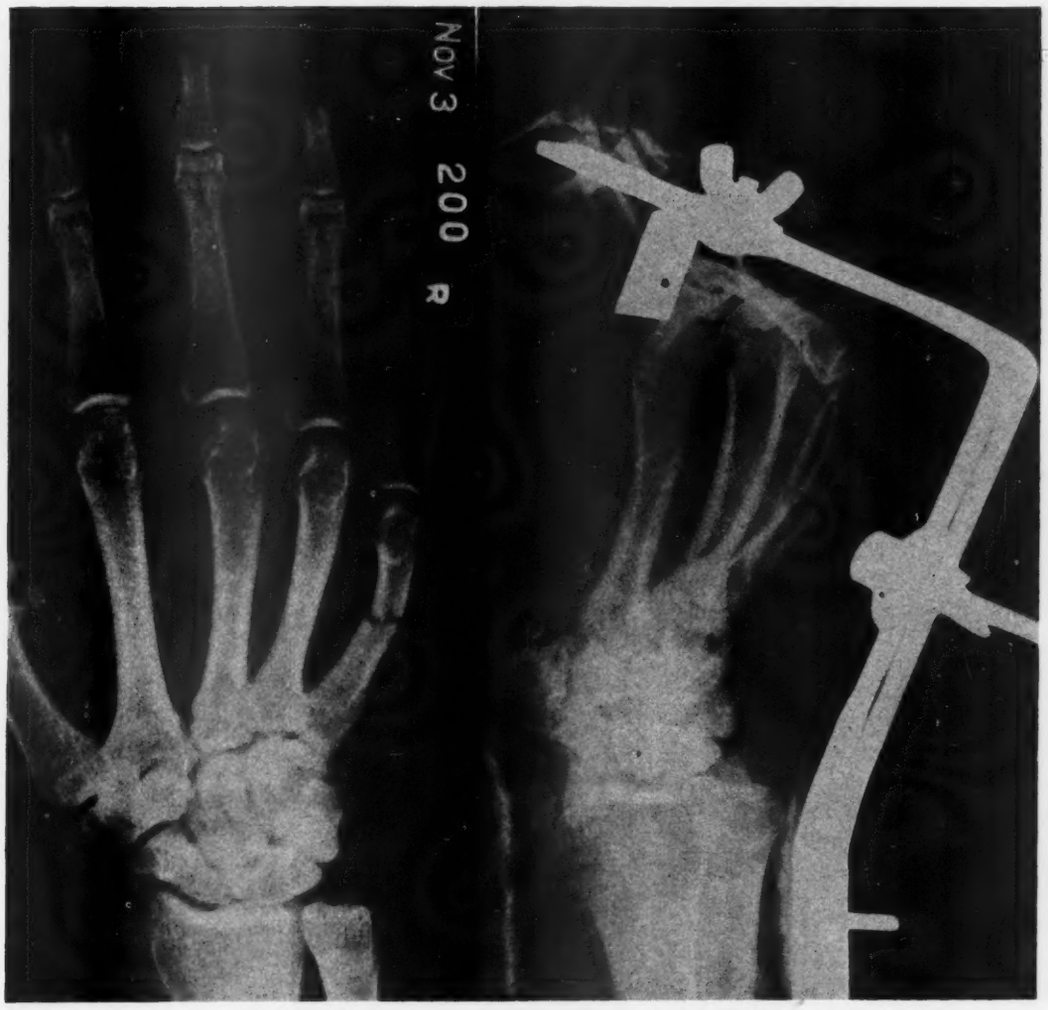

FIG. 5A FIG. 5B

FIG. 5. A, L. P., twenty-two years of age, fracture of the fifth metacarpal upon admission, November 3, 1942. A lateral view which really demonstrates that the degree of angulation was not available. B, November 9, 1942. Fracture reduced and anatomical restoration of position is maintained by the instrument.

dispersed into the soft parts rather than into the fracture site. Aspiration of bright red blood prior to injection and back pressure into the syringe when the plunger is released during injection may be taken as evidence that the needle is in the hematoma. After 2 or 3 cc. of novocaine solution have been injected the patient may complain of increased pain at the fracture site. This is probably due to the subperiosteal distention. Pain rapidly subsides and analgesia is usually complete in ten to fifteen minutes.

Reduction. The first step is that of breaking up the impaction. This is accomplished by forcefully manipulating the fragments while strong traction is made upon the finger of the affected metacarpal. After the impaction is relieved, it is then necessary to correct the dorsal angulation and the depression of the metacarpal head. This is accomplished by exerting a downward pressure over the distal end of the proximal fragment and an upward or dorsal force upon the metacarpal head.

With the fracture once reduced, the operator will find that very little upward pressure on the head and downward pressure over the distal end of the proximal fragment is necessary to maintain the corrected position. However, an upward force cannot be made on the plantar

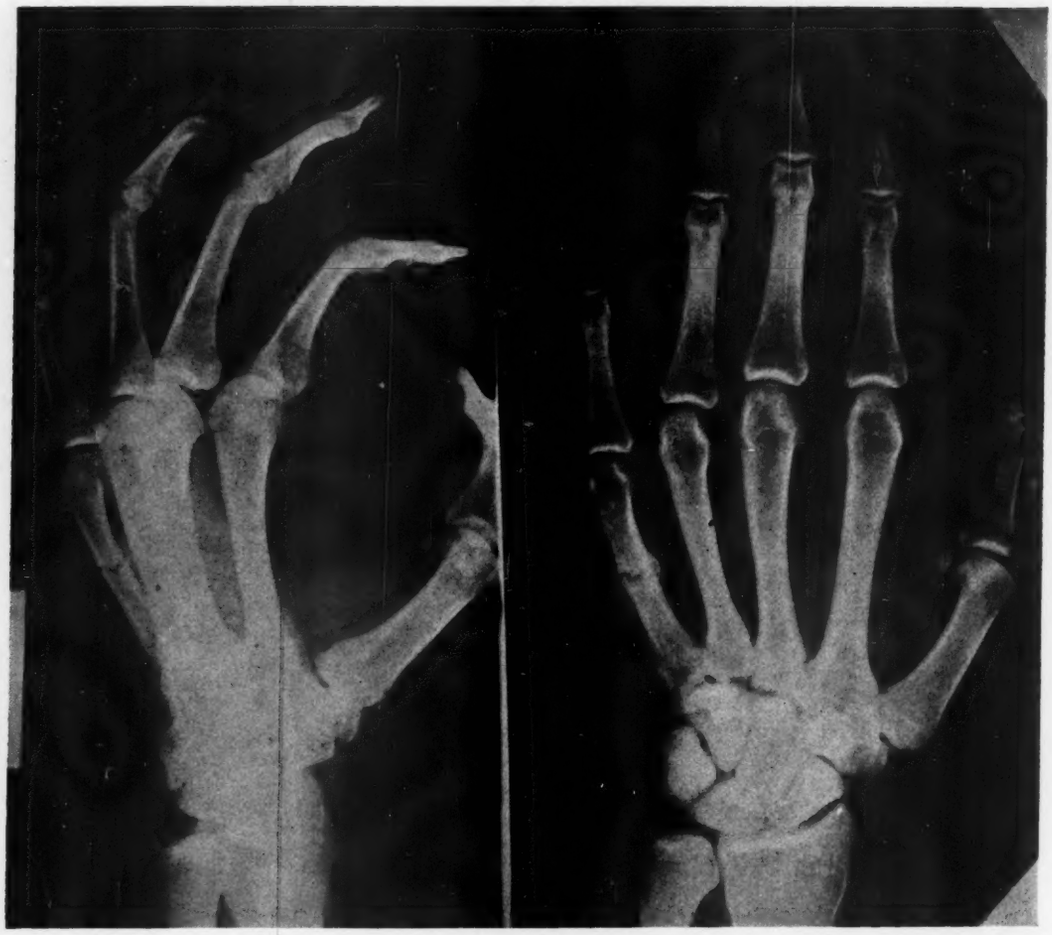

FIG. 5. C, December 15, 1942, six weeks after fracture. Splint has just been removed. Roentgenogram shows the maintenance of anatomical restoration of position. A moderate amount of callous can be seen. Note that the fifth finger can be fully extended. Complete restoration of function was obtained three days later.

surface of the metacarpal head for any great length of time without the expectation of complications. Pressure of any consequence for three to five weeks on the intervening flexor tendon sheath would irritate its membrane and result in thickening and adhesions. In order to eliminate pressure over the flexor tendon sheath, the first phalanx is flexed to a right angle at the metacarpophalangeal joint. This places the base of the proximal phalanx beneath the head of the metacarpal. Pressure upward on the proximal phalanx now forces the metacarpal head upwards. The proximal interphalangeal joint is then flexed to an angle of 90 degrees. Very slight pressure exerted upwards against the head of the proximal phalanx easily maintains elevation of the metacarpal head and the corrected position of the fragments. The amount of pressure necessary is merely the equivalent of the angulating force caused by the pull of the interosseous muscle.

APPARATUS

The armamentarium necessary to maintain the corrected position of the fractured metacarpal consists of a simple and easily applied apparatus best described in the accompanying photographs and diagrams (Figs. 2, 3, and 4), one four-inch roll of plaster of paris bandage, a small piece of 3″ stockinette and any skin adherent. As a finished product and made of aluminum or plastics when priorities permit, the entire apparatus will weigh merely a few ounces.

Fig. 6A

Fig. 6B

Fig. 6. A, E. C., twenty-four years of age, fracture of the fifth metacarpal upon admission, December 7, 1942. B, January 22, 1943, six and one-half weeks after fracture. Excellent alignment of the fragments has been maintained. A moderate amount of callous can be seen. Function was complete a few days after removal of the instrument.

FIG. 7A

FIG. 7B

FIG. 7. A, photograph showing an old healed fracture of the fifth metacarpal treated by splinting over a roll of bandage. Note the dorsal angulation and deformity. The same hand shows a recent fracture of the second metacarpal. B, after closed reduction and application of apparatus.

Application of Instrument. To apply the apparatus the upper and lower screws (Fig. 3A and B) are loosened. The skin adherent is applied about the wrist and distal forearm. This area is covered with 3″ stockinette. About five turns of the plaster of paris bandage are taken immediately proximal to the wrist joint over the stockinette. The instrument is then placed over the involved metacarpal and the remainder of the plaster roll is used to secure the instrument to the dorsal aspect of the distal part of the forearm. The plaster sets in a few minutes and the instrument is ready for use. During this procedure the patient maintains the corrected position of the fragments by placing the index finger of the other hand over the fracture site and his thumb beneath the head of the flexed proximal phalanx, thus making an assistant unnecessary.

The upper set screw is then adjusted so that the pressure plate rests directly over the metacarpal and proximal to the fracture line. The lower support bracket is raised so that it approximates the dorsal surface of the flexed second and third phalanges. The knuckle is thus maintained in its normal prominent position.

If the fifth metacarpal is involved, it will be noticed that the terminal two phalanges will deviate radially. Hence, a third set screw (Fig. 3C) is placed at the lower support in order to adjust it to the proper angle. The lower support is slightly cupped for comfort. The upper plate is supported

FIG. 7. C, twenty-two days after reduction. Compare the anatomical alignment of the second metacarpal treated with the apparatus described and the poor alignment of the fifth metacarpal treated over a roll of gauze bandage.

by a universal joint in order to allow for slight variations in the size and shape of the hand and still maintain an even distribution of force throughout the entire contact surface which is covered with a felt pad.

If swelling is present on the day following application of the device, either one or both of the set screws can easily be adjusted and thus avoid pressure necrosis of the skin. It will nevertheless still be possible to maintain the necessary force to counteract the angulating pull of the interossei.

After a few days all swelling will have subsided. Some fibrous union of the fragments will have taken place. The operator can then hold his finger beneath the metacarpal head, loosen the lower support and carry the flexed proximal interphalangeal joint through a full range of motion. The finger can also be cleaned with alcohol and the skin protected with any oil or cream. This latter procedure should be carried out three times a week during the entire stage of fixation in order to prevent a flexion deformity at this joint.

The fragments should be supported for about three to five weeks, or until *x*-ray evidence shows sufficient callous about the fracture site to prevent the pull of the interossei muscles from reangulating the fragments.

When callous appears adequate and the apparatus is finally removed, there is a complete restoration of position without evidence of deformity in any portion of the hand. Two to three days after the removal of the apparatus, patients have been returned to full military duty without any resultant difficulty.

Two instruments may be used side-by-side where more than one metacarpal bone is fractured.

CONCLUSION

A new apparatus has been devised for the treatment of the transverse and im-

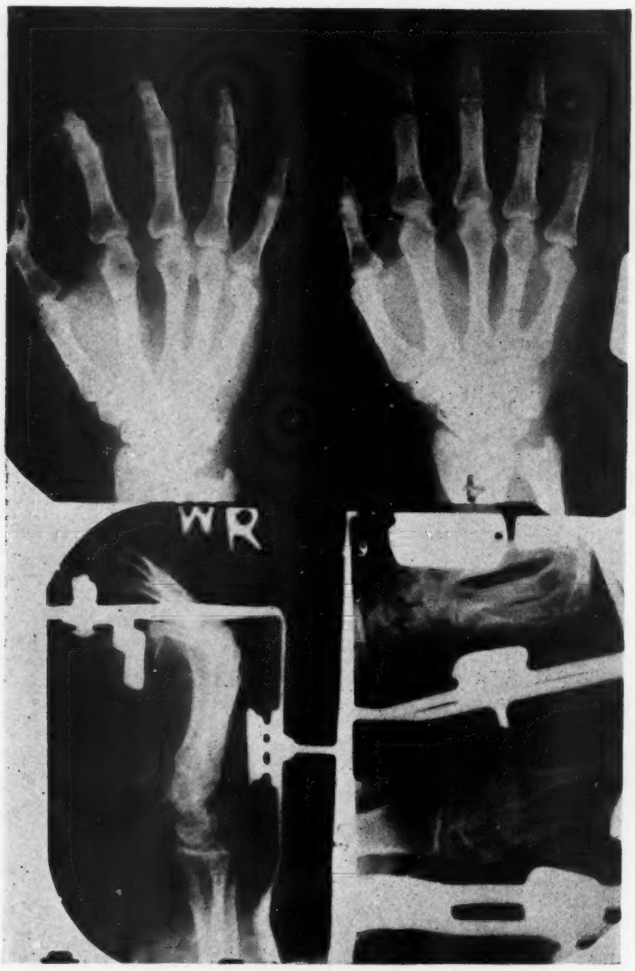

FIG. 8A

FIG. 8B

FIG. 8. A, F. G., fracture through the neck of the fifth metacarpal first seen ten days after the injury, April 20, 1944. B, April 28, 1944, excellent alignment. The patient was discharged to full army duty with complete function eighteen days after reduction.

pacted fractures of the last four metacarpal bones. The method of reduction and the use of pressure pads of one form or another have often been used in the past. This instrument, however, can easily be applied and adjusted without fear of pressure sores, infection, loss of position or deformities. It is a simple instrument which anatomically and physiologically answers the purpose of the general practitioner.

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A SIMPLE UTERINE SOUND MARKER

DAVID J. WEXLER, M.D.
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ISLIP TERRACE, NEW YORK

THE depth of the uterus or length of the cervical canal is frequently measured as part of many diagnostic and operative gynecologic procedures.

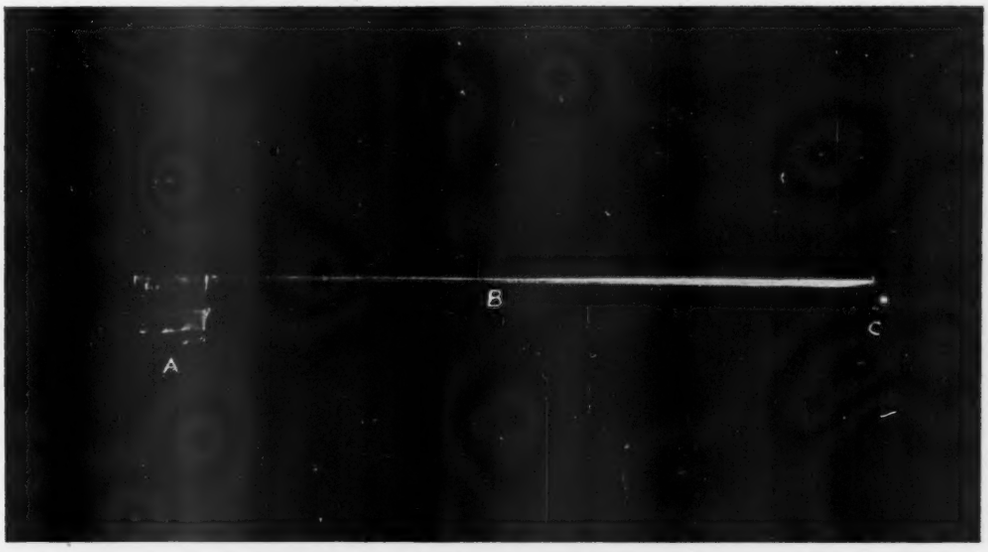

FIG. 1. Uterine sound marker.

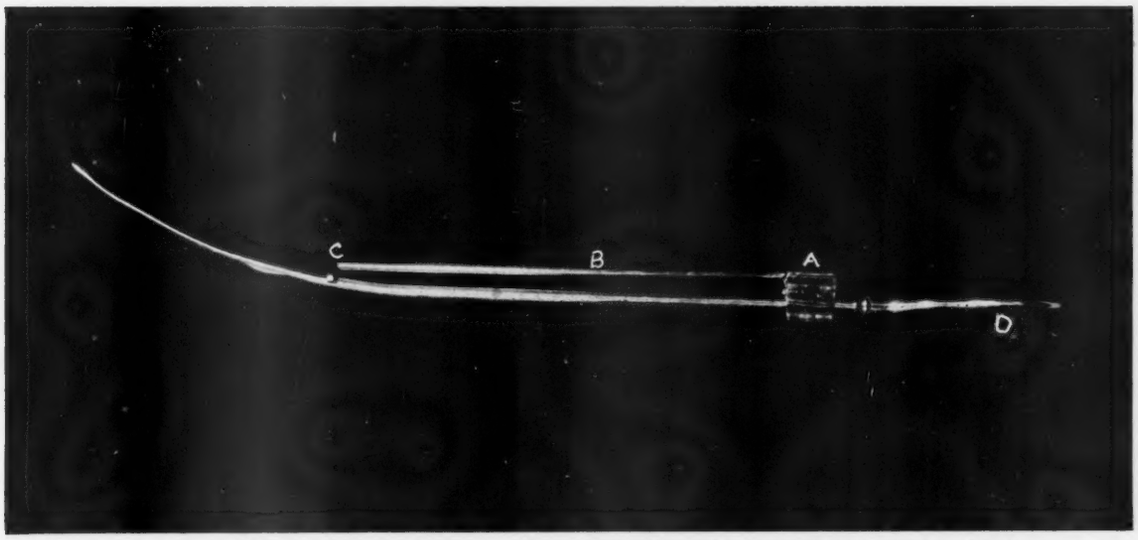

FIG. 2. Uterine sound marker attached to graduated sound producing accurate uterine depth gauge.

When the graduated sound is used in the operating room with the cervix pulled down by a tenaculum, it is usually possible to put the finger on the sound against the cervix and use it as a marker to indicate the depth of the uterus. However, when a bi-valve speculum is used either in the office or the operating room most men rely on the moisture from mucus or blood on the sound to act as a marker. This usually gives one a rough idea of the length of the uterus. Many times there is insufficient

moisture to act as a mark long enough to observe when the sound is withdrawn. At times if there is bleeding the sound is smeared generally and the estimate of the size of the uterus becomes less accurate.

To overcome the inaccuracy and to insure exact measurements of the cervical canal and the uterine cavity with ease, the marker illustrated was devised. "A" is the spring clip which snaps on and holds rod "B" and indicator "C" on the graduate sound "D." Together the sound and the marker constitute an accurate uterine depth gauge.

In use the instrument is clipped as shown on the sound. It is small enough not to interfere with vision as the sound is inserted in the external os. When the tip of the sound has reached the internal os or the superior wall of the uterine cavity, whichever distance one desires to measure, the marker is pushed forward until the indicator is against the cervix. The sound is then withdrawn and the indicator shows the exact measurement without guesswork. In cases in which an effort is being made to develop an infantile uterus, progress even in fractions of an inch can be ascertained.

RETROFLEXON, simply defined, is a bending backwards of the uterus, i.e., of the body upon the cervix. The latter may still be directed normally downward and backward, but more frequently has tilted downward and forward (erect position of the woman) toward the symphysis as the fundus falls backward.

From "Textbook of Gynecology" by Emil Novak (The Williams & Wilkins Company).

CASSETTE HOLDER FOR THE HAWLEY TABLE*

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Assistant Visiting Orthopedic Surgeon, Metropolitan Hospital
NEW YORK, NEW YORK

IN order to facilitate the taking of anteroposterior *x*-ray films during the operation of hip nailing, an inexpensive cassette holder has been devised. When placed under the patient on the Hawley fracture table, repeated films may be obtained without disturbing the position of the patient on the table.

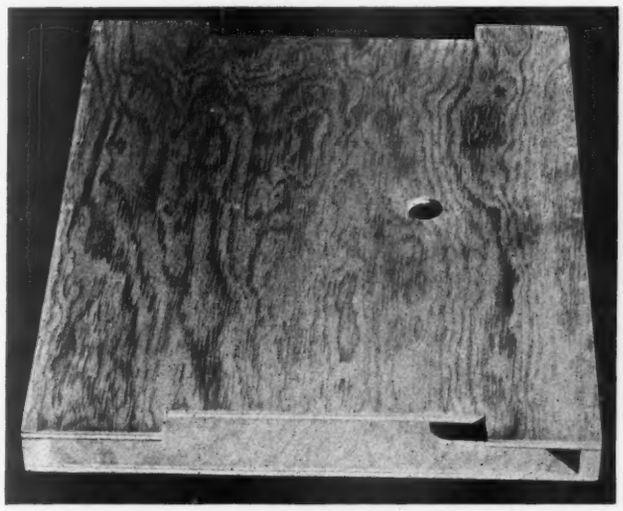

FIG. 1. Tunnel cassette holder, showing 11 inches by 1 inch section removed from each side to facilitate handling of cassettes, and hole for post of table in distal part.

In use, the sacral rest of the Hawley table is removed, following which the cassette holder is placed with its greatest length across the table, and the opening centered over the hole for the center post. The patient is then placed on the tunnel box, the center post inserted through the openings into the post of the table. A 10 by 12 inch cassette is then inserted into the tunnel on the appropriate side, so that the proximal and distal edges are centered for the patient, and the medial border rests against the center cleats. The *x*-ray is now taken, and when it is developed will include the entire pelvis to the midline. During operation, the technician has merely to raise the drapes from below, remove the exposed cassette, and substitute another for the next exposure.

The holder consists of a plywood tunnel. (Fig. 1.) Its construction requires two pieces of $\frac{3}{8}$ inch three layer plywood, 20 inches by 24 inches, and a piece of $1\frac{1}{8}$ inch by $\frac{7}{8}$ inch finished stock which is cut into two 24 inch lengths, one $12\frac{1}{2}$ inch length, and one $4\frac{1}{4}$ inch length. Wire brad finishing nails $1\frac{1}{4}$ inches long are also needed.

One of the pieces of plywood is prepared by removing a 1 inch section along each short side commencing 5 inches from one end (which will become the proximal end) and running for 11 inches, so that the uncut remainder is 4 inches. The two pieces now are drilled for the post, using a $1\frac{1}{4}$ inch augur bit, centering the hole 6 inches from the bottom along the center line of the long ends.

*From the Department of Orthopedics and Fractures, Metropolitan Hospital, Dr. Milton J. Wilson, Director.

The cut pieces are now placed above each other and separated by the cleats previously prepared, using the 1⅛ inch side for separating purposes. The 24 inch pieces lie along the top and bottom, respectively, and the longer of the short pieces lies along the center line proximal to the opening. The remaining cleat, therefore, lies along the center line from the hole distally. These pieces are then nailed together using the brads. The entire assembly is shellacked, then varnished, and when dry is ready for use.

CONCLUSION

An inexpensive, simply constructed cassette holder for use with the Hawley fracture table has been described. Its use during the nailing of intracapsular fractures of the neck of the femur is recommended.

PATIENTS with fractures of the lower limb never should be transported until after splinting has been applied. Hospitalization is necessary for the modern treatment of fractures of the leg. Order X-ray examination before deciding upon the method of further treatment.

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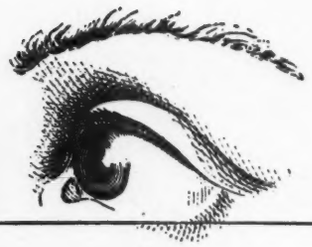

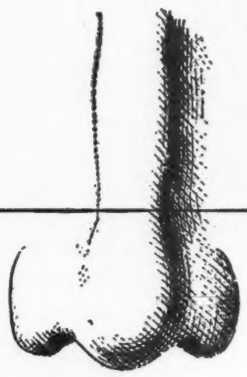

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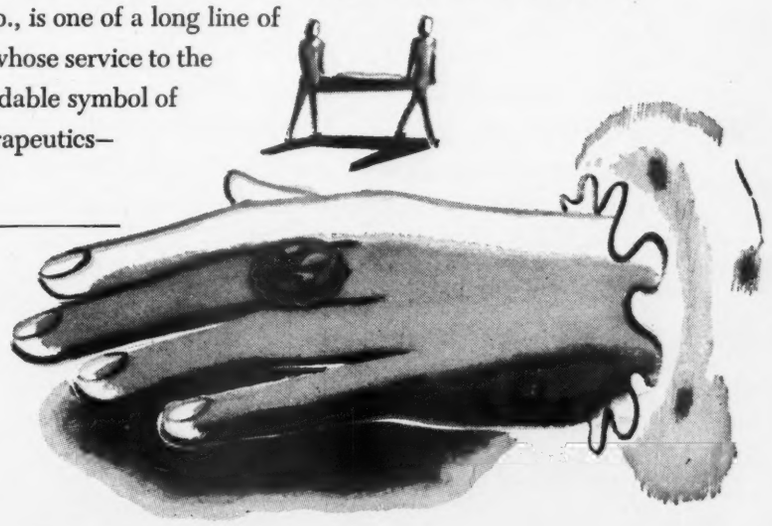

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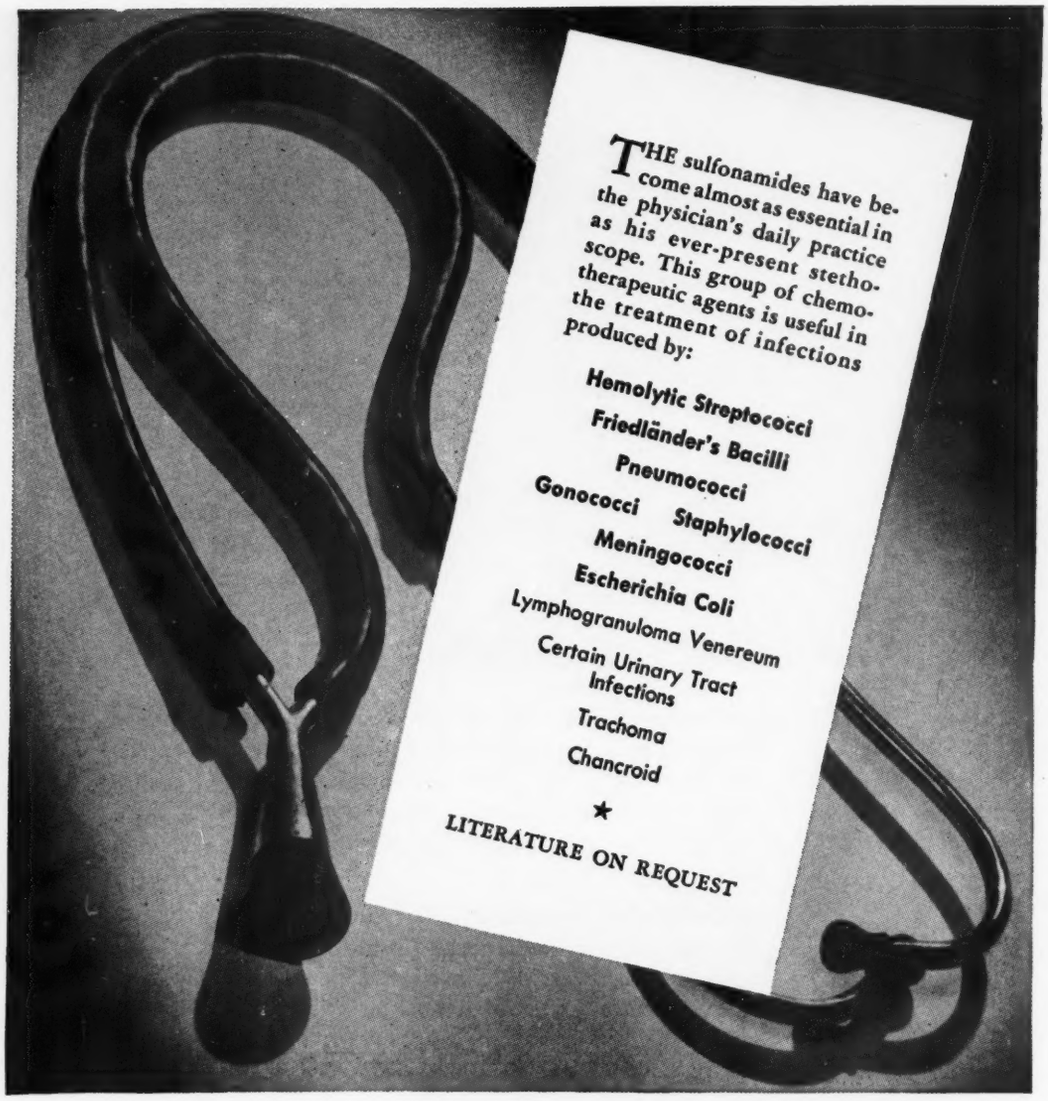

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*Kruse, H. D.: Proc. Conf. Convalescent Care, N. Y. Acad. Med. 1940, pp. 15-36.

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*Brougher, J. D., Prevention and Treatment of Postpartum Fissured Nipples with Local Applications of Vitamin A and D Ointment, West. J. Surg., Obst. and Gyn. 52:520, 1944.

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Vitamin A The need for large amounts of vitamin A by arthritic patients is based on the observation that arthritics require from 4 to 10 times the quantity of vitamin A usually ingested in the average diet, hence the frequent occurrence of vitamin A deficiency symptoms in patients afflicted with chronic arthritis.

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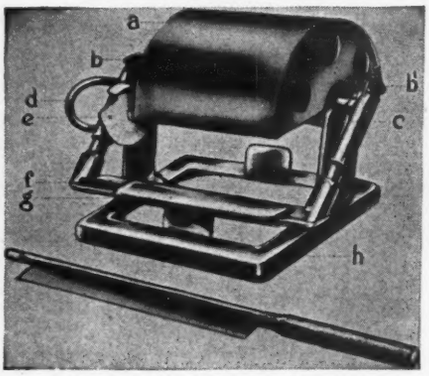

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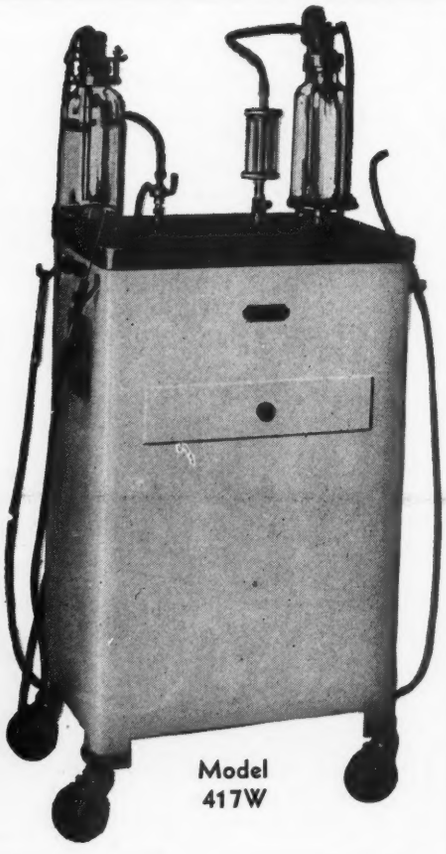

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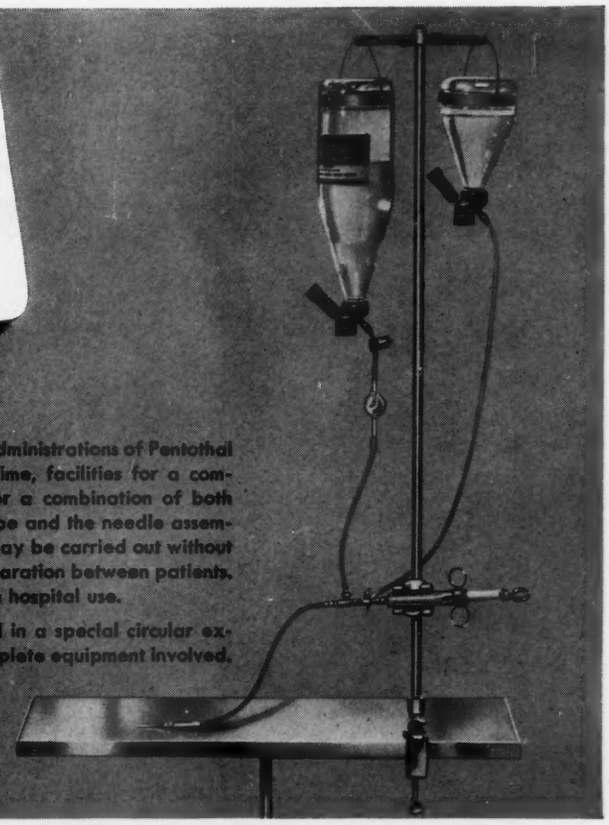

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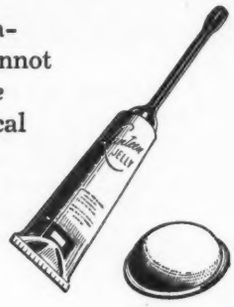

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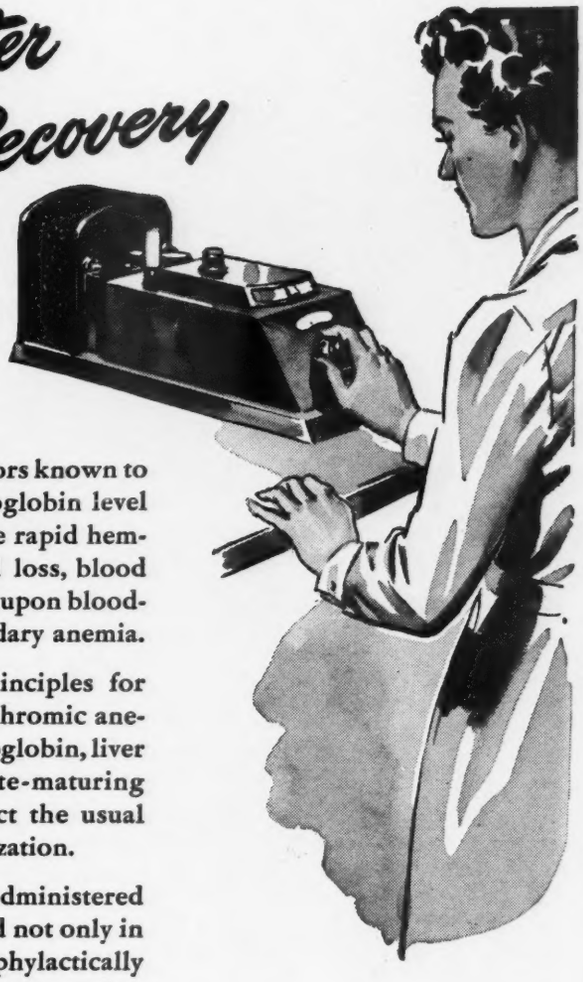

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